NECK DISSECTION

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WERE it not for the tendency of malignant tumors to metastasize, the problem of treatment—concerned only with the primary lesion—would be relatively simple. The degree to which metastasis can be prevented or controlled is actually the main factor that determines the prognosis for cure. In cancer of the mouth, pharynx, larynx, and skin of the head and neck, the cervical lymph nodes constitute the only protective barrier that, for a time, may confine the metastatic growth to an area accessible to treatment by surgery or radiation therapy. Once beyond this barrier, cancer of the head and neck is, to all intents and purposes, hopelessly advanced.

In each of the separate anatomical varieties of mouth and pharynx cancer, i.e., lip, tongue, nasopharynx, larynx, etc., the treatment techniques (surgical or radiological) differ or vary greatly. Most of the published reports on this subject are largely limited to discussion of the primary lesion, and little consideration is given to what is actually the major problem and one common to all forms of head and neck cancer, namely, THE MANAGEMENT OF CERVICAL METASTASIS. In the present study, little reference will be made to the treatment of the primary lesion, and most of the discussion will be directed toward the treatment of cervical metastasis—specifically by neck dissection.

Neck dissection, like radical mastectomy and abdominoperineal resection of the rectum, has finally become a standardized operation. Although there are many recorded cures of histologically proved cervical metastasis by radiation therapy,[42] nevertheless, in actual practice, neck dissection is generally accepted as the most effective method of treatment.

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Historical Review

The credit for the development of neck dissection as a curative operation for cervical metastasis belongs mainly to George Crile, Sr., whose investigations concerning this problem began in the latter part of the nineteenth century. In the medical writings of the early 1800's, there is little or no mention of any surgical procedure capable of curing or even arresting the progress of mouth cancer once the disease had spread to what were usually referred to as the "cervical glands." Thomas, in 1820, makes no mention at all of cervical metastasis. Chelius, in 1847, states that "the neighbouring lymphatics and glands become hard and painful" but that "once the growth in the mouth has spread to the submaxillary gland [sic], complete removal of the disease is impossible." In 1847, Warren reported the attempted removal of "cancer of the neck with an incision from the masseter to the clavicle," but it is obvious that the operation was a pure improvization of the moment without any previously conceived plan based on anatomical considerations. In 1880, Kocher described an operation in which the tongue was removed for cancer through the submaxillary triangle first "clearing out the lymphatic glands and the sublingual and submaxillary salivary glands" [translation]. It is plain, however, that the removal of these "glands" was incidental rather than a previously conceived or planned procedure. Later, Kocher proposed the idea that involved cervical lymph nodes should be removed more widely, and he introduced the so-called "Kocher incision," Y shaped, with a long arm running from the mastoid process down to the level of the omohyoid along the anterior border of the sternomastoid and a short arm running at right angles up to the submental region. In 1881, Packard,[32] in discussing lingual cancer, states that "all lymphatics, the submaxillary gland, and the sublingual gland are often completely removed," but this observer gives little evidence that he was familiar with the surgical anatomy of such procedures.

Staniel Boyd in his revision of Druitt's *Modern Surgery* published in 1887 does not describe any systematic procedure that could be considered as neck dissection, but nevertheless he does mention that the removal of metastatic cervical lymph nodes "frequently involves the laying bare of the carotid, jugular, and vagus." He also states that the internal jugular vein can be injured without untoward results. Butlin, in 1900, advised the removal of the cervical lymphatics through the Kocher incision and even discussed the routine excision of neck nodes prophylactically in cancer of the tongue. In 1893, Sutton recognized the necessity for removing cervical metastasis in operations for cancer of the mouth but apparently had no conception of the operation known today as neck dissection. He refers to the technique as follows: "When adjacent lymph glands are enlarged they should be dissected out coincidently with the removal of the primary lesion." In 1904, von Bergmann and von Bruns advised the removal of involved cervical lymph nodes. Their operation, however, was not systematic but was described simply as an "extensive extirpation of the glands" [translation].

As previously mentioned, the credit for designing and practicing a systematic operation of neck dissection on an anatomical basis goes to Crile,[17] whose first report on this subject was published in 1906. He actually attempted complete removal of the cervical lymphatics. Crile recommended anesthesia by tracheal intubation, complete removal of the sternomastoid muscle, the internal jugular vein, and all of the areolar and lymphatic tissue of the various triangles of the neck. Curiously enough, he advised temporary occlusion of the common (rather than the external) carotid artery for hemostatic purposes. He was one of the first to warn that permanent ligation of the common or the internal carotid artery was a dangerous procedure, and he called attention to the high mortality due to "cerebral softening." Crile also advocated at that time, and occasionally practiced, resection of the floor of the mouth and the tongue in combination with neck dissection. This pioneer surgeon emphasized that the cure rate for the operative removal of cervical metastatic cancer could be considerably improved if a radical operation was performed, rather than a partial procedure in which the muscles and veins were not removed.

Since the time of Crile a great deal has been done to standardize the operation of radical neck dissection. Throughout the first half of the twentieth century there have been, and still are, several surgical schools of thought that favor the more conservative operations,

such as submaxillary dissection, dissection to the level of the omohyoid muscle, or preservation of the sternomastoid muscle, internal jugular vein, and spinal accessory nerve.

Source of Clinical Data

The present report is based upon an experience of about 1450 cases of neck dissection performed at Memorial Hospital during the period 1928 to 1950. The operation has been used with a steadily increasing frequency on the Head and Neck Service, as is illustrated by the fact that in 1928 there were two radical neck dissections performed, while in 1950 there were a total of about 190. This increase is obviously due, not only to its wider application, but also to the fact that a steadily increasing yearly number of patients have been admitted to our clinic.

The statistical data are derived from a consecutive series of 665 operations in 599 patients during the period 1928 to 1945, inclusive. In this series, the anatomical diagnoses (proved histologically in all cases) are shown in Table 1. From this table it will be seen that the tongue is the most frequent (24 per cent) primary site of cancer requiring neck dissection. In a previous report from our clinic,[10] a table was published listing the relative frequency of primary sites of cancer giving rise to cervical metastasis in a consecutive series of 500 cases. It is significant that in the present study cervical metastasis from tongue cancer also comprises one quarter of the total, which indicates that in our clinic the procedure of neck dissection is not selected on the basis of the primary site but rather is performed on the basis of the relative incidence of cervical metastasis.

Table 1

ANATOMICAL SITES OF PRIMARY LESIONS IN 665 CASES OF NECK DISSECTION, 1928 to 1945

Site of primary lesion	Total patients			Total operations	
	Total	Unilat. neck dissect.	Bilat. neck dissect.	No.	%
Tongue	144	131	13	157	23.6
Lip	86	73	13	99	14.9
Thyroid	76	60	16	92	13.8
Gum	48	42	6	54	8.1
Mucosa of cheek	44	40	4	48	7.2
Floor of mouth	41	37	4	45	6.8
Skin of head and neck	34	30	4	38	5.7
Major salivary glands	29	29	—	29	4.4
Intrinsic larynx	18	18	—	18	2.7
Tonsil	15	15	—	15	2.3
Palate (hard and soft)	12	10	2	14	2.1
Extrinsic larynx	9	7	2	11	1.7
Nasopharynx	4	3	1	5	0.7
Paranasal sinuses	3	3	—	3	0.4
Misc. sites	36	35	1	37	5.6
Total	599	533	66	665	100.0

Age and Sex. Of the 599 patients whose cases comprise the statistical basis for this report, the youngest was aged 8 years, and the oldest was 92 years of age. Although all age decades up to the tenth were represented, almost 80 per cent of the patients were in the fifth, sixth, and seventh decades of life; more than 30 per cent were in the sixth decade alone. About 80 per cent of the patients were males, and 20 per cent, females. With respect to both age and sex, the incidence of this series of operations corresponds with the age and sex incidence of head and neck cancer in general.

Definitions

Radical Neck Dissection. The term as used in this report refers to an operation that purports to remove as thoroughly as possible, from the lateral and anterior aspects of the neck, the lymphatics (lymph nodes and lymphatic vessels) that are likely to be involved by metastatic cancer. The field of the operation should begin above at the lower edge of the mandible and extend to the level of the clavicle below. Anteriorly, the dissection should begin in the mid-line of the neck and be carried posteriorly to the anterior edge of the trapezius muscle. The procedure should include the removal of the sternomastoid and omohyoid muscles, the internal jugular vein, and the submaxillary salivary gland, en bloc.

Partial Neck Dissection. When the field of dissection is confined to a specifically limited portion of the neck, such as the submaxillary area and the supraomohyoid region, the term "partial neck dissection" should be used. An operation recommended by some surgeons to clear out the submental region and the anterior portions of both submaxillary triangles, without excision of the submaxillary salivary glands, should also be classified as "partial" rather than "bilateral" neck dissection. Operations that extend down only to the level of the omohyoid[35, 62] are often erroneously termed "radical" or "block" dissection. The latter procedure would necessitate section of the internal jugular vein at a point 4 or 5 cm. above the level of the clavicle and therefore would directly cross the mid-jugular nodes

and leave in place the lower nodes of the internal jugular chain—one of the most vital areas of the neck. In our opinion, these procedures should be classed as partial, rather than as complete, operations. Most experienced surgeons agree that in radical neck dissection the sternomastoid muscle, the internal jugular vein, and the submaxillary salivary gland should be excised along with the lymphatics.[6, 8, 12, 15, 35]

Bilateral Neck Dissection. This term should be restricted to those cases in which radical neck dissection is performed on both sides of the neck, usually in two stages.

Neck Dissection Combined with Excision of Primary Lesion. This procedure refers to a one-stage operation in which unilateral radical neck dissection is combined with the excision of the primary lesion in the mouth, pharynx, larynx, parotid, thyroid, etc. In such cases, when the primary lesion is in the mouth, the operation usually includes a partial segmental or a marginal resection of the mandible. These combined operations have been carried out on the Head and Neck Service of Memorial Hospital in about 490 cases since 1942.

Prophylactic Neck Dissection. When the adjective "prophylactic" is used to modify the term "neck dissection," it is ordinarily understood that the operation was performed in the absence of clinically demonstrable cervical metastasis. The term implies, therefore, that the procedure was intended to PREVENT, rather than to CURE, metastatic cancer. Obviously, the adjective is not well chosen in this regard, for the only means of preventing metastasis is to eradicate the primary lesion before such spread can occur. If metastasis has already taken place, neck dissection cannot possibly prevent such spread subsequently. Throughout the remainder of this discussion, however, the term "prophylactic dissection" will be used with its customary meaning as applied to operations that are done in the absence of clinically demonstrable involvement of cervical lymph nodes by cancer.

DIAGNOSIS OF CERVICAL METASTATIC CANCER

A tentative clinical diagnosis of cervical metastatic cancer must invariably depend upon the discovery by the physician of an enlarged node (or nodes) in the neck.* At this point in the discussion it is essential to define what is meant by "enlargement" of a lymph node. Notwithstanding an apparently widely accepted belief, lymph nodes are not necessarily "enlarged" simply because they are palpable. Normal nodes may vary in size from less than 1 mm. to 1.5 cm. or more in diameter. The larger normal cervical nodes (1 to 2 cm. in diameter) are readily palpable but are found only in certain locations, such as the upper deep cervical (subdigastric), the prevascular, and retrovascular areas. The occurrence of lymph nodes larger than 1 cm. in other regions of the neck can usually be regarded as an abnormal finding and is of particular significance when there is a history of a primary growth of cancer. More important than actual enlargement and palpability of the cervical lymph nodes is the fact that such enlargement is UNILATERAL OR ASYMMETRICAL. In the last analysis, however, the decision as to whether a lymph node is clinically involved must be made by the examining physician.

* In the medical literature, lymph nodes are sometimes referred to as "lymph glands" or simply as cervical, axillary, abdominal, etc., "glands." Medical dictionaries and anatomy texts use both terms. Such terminology arises obviously from the time when the function of lymph nodes was not clearly differentiated from that of the true cervical glands (parotid salivary, submaxillary salivary, lingual salivary, and thyroid and parathyroid glands). The impropriety of referring to lymph nodes as lymph "glands" is not so much that it is incorrect as that it is confusing and therefore inadvisable. For instance, in the literature on intraoral cancer, in the discussion of cervical lymph-node metastasis, cervical "glands" are often spoken of as being "palpable," "enlarged," "soft," "hard," and even as being "present" or "absent." What conclusion can the helplessly confused reader make when an author reports that cancer arising in the parotid salivary gland or in the thyroid gland has "metastasized to the cervical glands," or when a surgeon states that he has removed the "cervical glands" in operating on thyroid cancer?

Critical reading and personal communications with surgeons who speak of cervical lymph-node metastasis as "glands" force one to the conclusion that many of those who employ such terminology confusedly believe that cervical metastasis from cancer may take place indiscriminately to the various "cervical glands," that is, not only to the lymph nodes but to the parotid salivary, submaxillary salivary, sublingual salivary, thyroid, and parathyroid glands, and that all of these "glands" are of equal significance from the standpoint of treatment. This error in terminology is often a source of anxiety to the inexperienced physician who may discover the presence of palpable, but otherwise normal, submaxillary salivary, parotid salivary, and thyroid glands and interpret such findings incorrectly. If the term "node" or "lymph node" is used instead of "gland" or "lymph gland," much of the confusion from this source would be eliminated.

(It is difficult to establish the possible margin of error in the clinical diagnosis of cervical metastatic cancer. In this connection, 200 cases of combined operations [excision of the primary lesion in the mouth plus neck dissection and resection of the mandible] performed on the Head and Neck Service were analyzed. In about 17 per cent of the cases in which the examiner could find no evidence of cervical metastasis, the nodes on histological examination were found to contain cancer. Since, in general, the primary lesions in these cases were so bulky as to be considered incurable by radiation therapy, the impending development of clinically evident cervical metastases was to be expected. For this reason, the figure of 17 per cent can hardly be taken as the anticipated margin of error in earlier and smaller lesions, especially in such anatomical sites as the lip or paranasal sinuses.

In the section on PROPHYLACTIC NECK DISSECTION IN CANCER OF THE LIP, the incidence of later metastasis, when none was found on the initial examination, was about 6 per cent. In any case, the diagnosis of cervical metastatic cancer must be based, in questionable cases, entirely on whether a given lymph node is palpably "enlarged" or asymmetrical as compared with the opposite side of the neck, a sign that, in most cases, is relative rather than absolute.)

It is important to emphasize that there are several landmarks in the neck that may be occasionally mistaken for an enlarged node, even by the experienced examiner, such as the greater cornu of the hyoid bone, the transverse process of the sixth cervical vertebra, or a prominent carotid-artery bulb.

In a given case of a known primary cancer, previously treated or untreated, the investigative steps toward establishing the true nature of an enlarged cervical lymph node should seldom go beyond an aspiration biopsy—that is, a single node should not be excised for biopsy purposes. The surgical scarring resulting from excisional biopsy of a node in the neck may often interfere seriously with subsequent neck dissection. Furthermore, histological study of an excised cervical lymph node will only establish a diagnosis of cancer but, in most cases, will not indicate the origin of the primary site of the growth. The latter anatomical factor can be established by painstaking clinical examination, repeated at frequent intervals, if necessary.

TABLE 2

LOCATION OF PRIMARY LESION IN 500 CONSECUTIVE CASES OF CERVICAL METASTATIC CANCER

Site	No.	%
Tongue	127	25
Floor of mouth	44	9
Extrinsic larynx	44	9
Nasopharynx	40	8
Lip	35	7
Tonsil	34	7
Mucosa of cheek	28	6
Metastatic from undetermined primary	28	6
Jaws	27	5
Pharyngeal wall	24	5
Palate	20	4
Skin of face	11	2
Thyroid	11	2
Miscellaneous sites	27	5
TOTAL	500	100.0

INDICATIONS FOR NECK DISSECTION

In the surgical literature on mouth cancer, there have appeared from time to time reports containing specific indications and contraindications for neck dissection. When viewed from present-day perspective, much of this can hardly be regarded as little more than pure dogma, supported neither by facts nor by statistical analysis of long-range clinical observations.

Another drawback in most reports on neck dissection[26, 48] is that the studies are based mainly on lip cancer with little reference to other anatomical forms of malignant growths in the mouth, pharynx, or larynx. Cancer of the lip is responsible for about 7 per cent of cervical metastasis[42] only, and, in any case, is the least malignant type of cancer in the upper respiratory and upper alimentary tracts. It is obvious, therefore, that cancer of the lip cannot be used as an adequate basis for evaluation of this problem, nor can any study of any single anatomical form of cancer be sufficient for a comprehensive survey of the whole problem of cervical metastasis or of neck dissection. Several years ago, a tabulation was made of 500 consecutive cases with cervical metastatic cancer as the patients came into the Head and Neck Clinic (Table 2).[42] This particular study was made with reference to the location of the primary lesion only and showed that, from the standpoint of frequency, tongue cancer is more important in cervical metastatic cancer than any other primary site, while cancer of the lip ranged only fourth. It is plain, therefore, that the problem both of cervical metastasis and of neck dissection should be regarded from a

broad perspective; it cannot be crystallized into a simple specific tabulation of indications and contraindications. The decision for or against neck dissection must rest on the merits of the individual case, guided, in our opinion, by the following basic principles.

1. *There Should be Definite Clinical Evidence that Cancer is Present in the Cervical Lymphatics.* Acceptance of this principle will immediately rule out the so-called "prophylactic neck dissection," a question to be discussed in detail later. The essential features in the clinical diagnosis of cervical metastatic cancer have already been reviewed in this report.

2. *The Primary Lesion Giving Rise to the Metastasis Should Have Been Controlled Clinically, or, if not Controlled, there Should be a Plan to Remove the Primary at the Same Time that Neck Dissection is Performed.* This fundamental surgical principle is subscribed to by others.[6, 28, 55, 61] While it might seem unnecessary to discuss such an obvious basic principle, patients are frequently seen in cancer clinics who have had neck dissections without any treatment whatever for a clearly established primary lesion. In these cases, the only possible explanation is that the surgeon believed that, by removing the cervical lymphatics, further metastasis could not occur from the primary lesion, since (it is reasoned) the metastatic emboli having no place to go would, therefore, not leave the primary lesion.

3. *There Should be a Reasonable Chance of Complete Removal of the Cervical Metastatic Cancer.* Too much emphasis is sometimes placed upon such a finding as "fixation" of the metastatic mass to the deeper structures of the neck (carotid vessels, prevertebral muscles, larynx, mastoid bone, vertebrae, mandible, etc.), the inference being that such fixation was absolute. FIXATION is a relative term, and its significance is a matter of degree rather than of kind. It is obvious that attachment to, or actual invasion of, some structures of the neck by metastatic cancer does not necessarily preclude complete removal if consideration is given to the possibility of resection of at least part of the invaded structures (vessels and nerves, mandible, larynx, etc.). Such contraindications as involvement of the skin or mandible have little practical significance in present-day surgical practice. It is in the discussion of the aforementioned extensions of the disease that the term "inoperable" has been somewhat loosely used. In most instances in which the term "inoperable" is employed, it implies that the surgeon who makes the decision does not himself feel competent to operate in a given case. In brief, operability frequently depends upon the experience, skill, and attitude of the individual surgeon. In most cases no other interpretation is justified on the basis of this vague terminology.

4. *There Should be no Clinical or Roentgenographic Evidence of Distant Metastasis.* Before embarking upon a radical procedure, surgical or radiological, in an attempt to cure a local focus of cancer either in the primary lesion, in some lymph-node group, or elsewhere, it should be established whether or not the disease has already disseminated widely. Obviously, neck dissection for cervical metastasis causing no subjective symptoms would hardly be justified in cases in which there are associated distant metastases. Nevertheless, in judiciously selected cases, despite the presence of early metastasis below the clavicle, palliative neck dissection may occasionally be indicated to relieve painful and other disabling symptoms of metastatic cervical cancer. The operation may even be employed to relieve intractable pain, even though the cervical mass itself cannot be completely removed.

5. *Neck Dissection Should Offer a More Certain Chance of Cure than Radiation Therapy.* In our opinion, wide surgical removal of the cervical lymphatics offers a better chance of cure than does radiation therapy under average conditions, that is, in cases in which the primary lesion is already under control or in which it can be removed at the same time that the neck dissection is performed. Under certain circumstances, however, neck dissection does not offer so good a chance for cure as does radiation therapy. We refer here to those cases in which the primary lesion is anatomically inoperable, as, for instance, in nasopharyngeal cancer or in extensive cancer of the tonsil, the pharyngeal wall, or the extrinsic larynx. In such instances, treatment of the primary lesion obviously must be by radiation therapy, usually given over a period of three to four weeks. In these cases, it is not reasonable to perform neck dissection in the beginning, nor is it prudent to defer treatment of the cervical metastasis until the primary growth is under control and

then to perform neck dissection two or three months later. In brief, in those cases in which the primary lesion itself must be treated by radiation therapy, any cervical metastasis already present should also be irradiated.

Dubious Contraindications to Neck Dissection. Certain supposed contraindications to this operation are often mentioned in reports previously published on neck dissection.[21, 26, 58, 61] For example, it has been stated that bilateral cervical metastasis constitutes a contraindication to neck dissection. This idea has been based upon the erroneous belief that bilateral complete neck dissection (including removal of both internal jugular veins) is not a safe procedure. The usefulness and safety of bilateral neck dissection (usually in two stages but occasionally in one stage) has been adequately proved in the present series of reported cases.

It has also been stated in the literature that neck dissection is contraindicated if the primary lesion encroaches upon, or extends beyond, the mid-line, since under these conditions bilateral neck dissection would have to be performed in order to encompass the disease.[35] The presence of contralateral cervical metastasis has also been advanced as a contraindication to neck dissection for the reason that bilateral neck dissection might become necessary in such cases. These supposed contraindications to neck dissection, which appear in the literature from time to time, have no basis in fact.

Choice between Surgery and Radiation Therapy for the Treatment of Cervical Metastasis

The selection of the particular form of treatment for cervical metastasis in a given case of cancer should be made solely in the patient's interest without consideration of either the patient's or the therapist's partisan preferance for one or another method. In other words, that procedure should be used INITIALLY that yields the highest percentage of cures in the greatest number of patients. Too often, in discussions of methods for the treatment of cancer, it will be found that surgeons will discredit the possibilities of radiation therapy and recommend it only for palliation in the hopelessly advanced or so-called "inoperable" case. On the other hand, radiation therapists often overemphasize the supposed hazards of surgery and make undue claims for radiation therapy. It is plain that the truth cannot be found by a compromise between two such extreme protagonistic views, and that it would be difficult for any individual therapist to assay correctly the relative advantages and disadvantages of the two methods unless he himself is experienced in the application of both.

Returning then to the principle that that treatment method should be selected in the beginning that serves the best interests of the patient, long-term observations in a large number of cases by clinicians employing both methods should make it possible to arrive at some definite conclusions following an analysis of several thousands of cases over a period of more than twenty-five years. Such has been the objective of the Head and Neck Service at Memorial Hospital. The following general principles have thus been evolved, and upon them are based our current practices. They are as follows:

1. In cervical metastatic cancer, surgery (neck dissection) is the method of choice in the majority of cases, since it is the most direct, the most readily controlled, and the most predictable method of therapy.

2. Radiation therapy is an indispensable method for the initial treatment of cervical metastasis in selected cases, for reasons already given under INDICATIONS FOR NECK DISSECTION. Radiation therapy is also useful, and often permanently successful, in the treatment of inoperable recurrences following neck dissection, as discussed under POSTOPERATIVE RADIATION THERAPY.

The question therefore is not so much whether it is possible to cure cervical metastasis by radiation as whether, from the purely objective standpoint, radiation gives an equal chance of cure. If one accepts these broad principles, there remains little controversy as to the choice between the two methods. Although competent clinicians might differ in marginal cases, and although the choice of treatment might vary as regards these marginal cases, the general principles, in our opinion, are sound and remain fixed for the majority of patients.

In the not too distant past, many surgeons apparently have felt that undue claims were being made for the efficacy of radiation therapy in the curative treatment of cancer and that, to correct this error, they felt justified in denying that radiation therapy had any

merit whatever. For instance, in 1937 Eggers made the statement that he had never seen a secondary cancer of the neck cured by radiation therapy. Others who speak disparagingly of the possibility of radiation cures for cervical metastasis are Blair and Brown, Coutard, Fischel,[27] and Leroux-Robert. Many radiologists, apparently on the basis of their personal experience, also feel that cervical metastatic cancer cannot be permanently controlled by radiation therapy. Such statements are not in accordance with the facts. In 1940, one of us reported the cases of forty-six patients with cervical metastatic cancer alive and well five years after treatment, and an additional forty-four cases alive and free of disease three years after treatment by radiation.[42] The possibility of cure of histologically proved cervical metastasis by radiation therapy alone occurs with such frequency in our clinic as to call for no particular comment. The question, then, is not whether radiation therapy can cure cervical metastasis in a given case, but whether radiation therapy is preferable for the reason that it gives as good or a better chance for cure than does surgery.

Experience has shown that cervical metastasis can be cured readily by radiation therapy, provided that the node or group of nodes is small or of moderate size. In other words, radiation therapy can frequently and permanently sterilize a single node or a localized group of nodes. So often, however, there are multiple metastatic nodes in the neck not demonstrable clinically that, in these cases, radiation therapy administered through small ports must inevitably fail, while neck dissection will succeed more often. Whereas neck dissection can be applied over the entire potentially involved field (mandible to clavicle, trapezius to mid-line), radiation therapy in cancer-lethal doses over such an extensive area could not possibly be tolerated by the patient.

Case for Prophylactic Neck Dissection

The question as to whether prophylactic neck dissection is a justifiable and useful procedure in contributing to the over-all cure rate of cancer of the mouth and pharynx has long been a controversial one. Among individual surgeons and clinics, there are those who strongly advocate this operation and others who hold that it is not warranted. Arguments have been advanced in support of the procedure by citing observations and end results for cases in which prophylactic neck dissection has been performed as a regular routine. Such arguments, provided that they are based upon accurate statistical analysis, are theoretically significant only if it can be shown that the cure rates for various anatomical forms of cancer are higher in cases in which neck dissection is practiced routinely, whether or not the cervical lymph nodes are palpably involved by metastatic cancer.

On the other hand, those who are opposed to this operation have also presented statistical data and observations in series of cases in which prophylactic neck dissection has not been performed and in which it is claimed that the cure rates are equally good. Such figures also are valid evidence in the case for or against prophylactic neck dissection.

Prophylactic neck dissection as a principle of treatment is not employed on the Head and Neck Service of the Memorial Hospital. Although such a policy has seemed reasonable to us, nevertheless, we have made certain statistical analyses recently to investigate the soundness of our position. When the statistical data were obtained they were presented in preliminary form to a number of cancer therapists. Sufficient difference of opinion appeared, so that we undertook to submit this material to a larger number in the form of a poll. This questionnaire was intended to elicit the manner of reasoning by which individuals arrived at their respective conclusions. These data, the questionnaire, an analysis of the replies, and our own summary are given in the following section.

Survey of the Prevailing Opinions on Prophylactic Neck Dissection

For the purpose of clarity and simplicity, the statistical data herein presented are reduced to a minimum, and only two anatomical forms of mouth cancer are discussed, namely, cancer of the lip and cancer of the tongue. The former is the least malignant form of cancer of the oral cavity; the latter is one of the most malignant forms of mouth cancer, and, because of its prevalence, is the greatest single killer of all varieties of cancerous growths occurring in the mouth. By citing such two examples, it is felt that a well-balanced and reasonable perspective regarding the advantages and relative merits of prophylactic neck dissection may be evaluated for these as well as for other forms of mouth cancer.

STATEMENT OF PRELIMINARY CLINICAL INVESTIGATIONS ON PROPHYLACTIC NECK DISSECTION AND QUESTIONNAIRE SENT TO SEVENTY-FIVE CLINICIANS

In order that the data presented in this report be clearly understood, it is essential that a number of terms be plainly defined.

Definitions. 1. The term PROPHYLACTIC NECK DISSECTION as used on the Head and Neck Clinic at the Memorial Hospital may be defined as an operation performed as a SEPARATE AND INDEPENDENT PROCEDURE (not in conjunction with excision of a primary growth) in patients in whom the primary lesion in the mouth or pharynx is supposedly already under control.

The adjective PROPHYLACTIC, as used here, is not considered applicable in those cases in which the removal of the cervical lymphatics is performed as an extension of, and in conjunction with, an operation where the primary growth is also excised. A concrete example of such a combined procedure is resection of the mandible for the removal of a primary tumor in the mouth; in these cases the upper neck must necessarily be opened and, therefore, the operative procedure is extended to encompass and remove the cervical lymph nodes on the homolateral side of the neck. The reason for performing a neck dissection under such circumstances (in the absence of clinically demonstrable cervical metastasis) is that the neck is opened in any case, and it is evident that a thorough neck dissection can best be done at that time, rather than at some later date, by which time the tissues in the operative field have become extensively scarred.

2. The term TOTAL EXPERIENCE is employed to designate the cases of all patients with cancer who apply to the Memorial Hospital. This category refers to all those who apply and embodies the advanced and apparently hopeless cases, as well as the early and moderately advanced, and specifically includes those patients with recurrent or residual disease who have been previously treated elsewhere by surgery and/or radiation therapy.

3. The term DETERMINATE CASES refers to the total experience as defined here, with the exception of those patients classified as indeterminate.

4. The term INDETERMINATE is applied to those cases of cancer in which the eventual outcome could not possibly have been affected by any treatment that was given, or could have been given, at the Memorial Hospital. The indeterminate group is made up of the following: a. Those patients already treated elsewhere who have no evidence of cancer on application to Memorial Hospital, who present themselves for follow-up examination only, and who develop no recurrences while under observation at the Memorial Hospital. b. Those patients who ask for an opinion only and who do not desire treatment. c. Those patients who do not accept treatment or palliative care offered at the Memorial Hospital. d. Those patients who within a five-year period die of other causes not related to the cancer or directly to complications following treatment for cancer. Examples of such other causes of death are diseases of cardiac or renal origin, cerebral accident, etc.

PROPHYLACTIC NECK DISSECTION IN CANCER OF THE LIP

Analysis of Some Recent Clinical Material from the Memorial Hospital. In a group of 421 consecutive cases of cancer of the lip (total experience, years 1935 to 1942), 124 were indeterminate. Of the remaining 297 determinate cases, 237 presented no clinical evidence of cervical metastasis on admission. These 237 patients might properly be considered CANDIDATES FOR PROPHYLACTIC NECK DISSECTION, but the practice of this procedure is not the policy on the Head and Neck Clinic at the Memorial Hospital and was not carried out in these cases.

Of these 237 theoretical candidates for prophylactic neck dissection, the primary lesion was not controlled in twenty; the cervical metastasis first appeared contralaterally in another four cases; and in an additional 187 cases cervical metastasis did not develop following control of the primary lesion. Thus, there were 211 patients (twenty plus four plus 187) for whom prophylactic neck dissection on the same side as the primary lesion would have been without possible benefit.

Subtracting these 211 cases from the total of 237, a balance of twenty-six cases would remain in which prophylactic neck dissection would have been at least of theoretical value had the operation been done initially.

Of these twenty-six patients in whom cervical metastasis developed after apparent control of the primary lesion, there were eleven

who were subsequently successfully treated for their metastases (five-year cures), either by radical neck dissection, by radiation therapy, or by a combination of the two.

Subtracting these eleven cases from the twenty six, there remain fifteen cases in which prophylactic neck dissection might have been of value had it been done initially.

Summary of the Preceding Data. In a consecutive series of 237 patients with cancer of the lip in whom prophylactic neck dissection would have been done had it been our routine policy, there remain only fifteen in whom it could possibly have been of value, or, in other words, in one in sixteen cases (6.25 per cent). In brief, fifteen useless operations would have been necessary in order to be of benefit in one case.

PROPHYLACTIC NECK DISSECTION IN CANCER OF THE TONGUE

Analysis of Some Recent Clinical Material from the Memorial Hospital. In a group of 233 consecutive cases of cancer of the tongue (total experience, years 1940 to 1942), thirty-two cases were indeterminate. Of the remaining 201 determinate cases, 120 presented no clinical evidence of cervical metastasis on admission. These 120 patients might theoretically be considered CANDIDATES FOR PROPHYLACTIC NECK DISSECTION, but, as previously mentioned, this procedure is not the policy at the Memorial Hospital and was not carried out in these cases.

Of these 120 theoretical candidates for prophylactic neck dissection, the primary lesion was not controlled permanently in thirty seven; the cervical metastasis first appeared contralaterally in another six cases; and in thirty-seven additional cases cervical metastasis did not develop following control of the primary lesion. Thus, there were eighty patients (thirty seven plus six plus thirty seven) for whom prophylactic neck dissection on the same side as the primary lesion would have been without possible benefit.

Subtracting these eighty cases from the total of 120, a balance of forty cases remains in which prophylactic neck dissection would have been at least of theoretical value.

Of these forty patients in whom cervical metastases developed after permanent control of the primary lesion, there were fifteen who were subsequently successfully treated for their metastases (five-year cures) either by radical neck dissection, by radiation therapy, or by a combination of the two.

Subtracting those fifteen cases from the forty, there remain twenty-five cases in which prophylactic neck dissection might have been of value had it been done initially.

Assuming a proportionately distributed operative mortality of 3 per cent in neck dissection, one of these twenty-five patients would have died of postoperative complications.

Summary of the Preceding Data. Of the 120 patients with cancer of the tongue with no evidence of metastases on admission, and in whom prophylactic neck dissection would have been done had it been our routine policy, there remain only twenty four in whom it could possibly have been of some value, or, in other words, in one in every five cases (20 per cent). In other words, four useless operations would have been necessary in order to be of possible benefit in one case.

QUESTIONNAIRE ON PROPHYLACTIC NECK DISSECTION

On the basis of the data presented herewith,

(1) Do you think that prophylactic neck dissection would be justifiable in cancer of the lip? YES_____ NO_____

On the basis of the data presented herewith,

(2) Do you think that prophylactic neck dissection would be justifiable in tongue cancer? YES_____ NO_____

(If your answer to both the foregoing questions is NO, you need not answer the succeeding question.)

On the basis of the data presented herewith, you have given your opinion that prophylactic neck dissection is justifiable in either one or both cancer of the tongue (of theoretical value in 1 case in 5) or in cancer of the lip (of theoretical benefit in 1 case in 16). On the basis of this opinion,

(3) Would you please further state at what point you think prophylactic neck dissection would not be justifiable on the basis of its chance of being of benefit. Please mark on the scale the point at which you think that neck dissection would no longer be justifiable.

1 in 5 (cancer of tongue in present analysis)	1 in 16 (cancer of lip in present analysis)
1 in 6	1 in 17
1 in 7	1 in 18
1 in 8	1 in 19
1 in 9	1 in 20
1 in 10	1 in 21
1 in 11	1 in 22
1 in 12	1 in 23
1 in 13	1 in 24
1 in 14	1 in 25
1 in 15	

The foregoing data and discussion relative to prophylactic neck dissection in cancer of the lip and cancer of the tongue were submitted with the accompanying questionnaire to seventy-five cancer therapists, mainly surgeons, but also to a few radiologists and directors of cancer clinics who were believed to be sufficiently interested and well informed on this subject to render worth-while opinions. In the questionnaire, it was asked whether on the basis of the data submitted and on previous personal experience these cancer therapists believed that prophylactic neck dissection was justified; and if they believed it justified, at what point on the scale of probabilities (1 in 5 etc., up to 1 in 25) each individual considered that the effort of performing a prophylactic neck dissection would be no longer worth while.

The questionnaire was intended not so much to assess the prevailing opinion for or against prophylactic neck dissection, as rather to learn of the statistical basis (if any) for the opinions of those who favored the procedure. For this reason, the questionnaire was not sent to any individual who was known to be opposed to the operation of prophylactic neck dissection. If one were to attempt an over-all survey for or against prophylactic neck dissection, the difficulty would be in determining to whom the questionnaire should be sent, for it is obvious that not all who treat cancer have any basis for holding any worth-while opinion except a purely theoretical one. Although obviously many cancer therapists have a real basis for an opinion, nevertheless, it would be difficult to establish which are qualified.

To these seventy-five questionnaires there were fifty-eight replies. About 46 per cent of those who answered stated unequivocally that they would not perform prophylactic neck dissection in either cancer of the lip or cancer of the tongue on the basis of the data submitted in the questionnaire and on the basis of their own personal opinions. A lesser number, about 40 per cent of those who replied, favored prophylactic neck dissection in some cases of cancer of the tongue, while 75 per cent were opposed to prophylactic neck dissection in cancer of the lip. Only 17 per cent of this group thought it indicated in all cases of lingual cancer, and only 10 per cent thought it should be done routinely in cancer of the lip. Of all the replies, about 10 to 15 per cent were vague and undecided, or held no opinion at all as regards one or more of the questions.

Despite the deliberate omission in this survey of all who were known to be opposed to the practice of prophylactic neck dissection, it appears, nevertheless, that there must be a definite preponderance of opinion against the procedure in cancer of the tongue and an overwhelming majority against it in cancer of the lip.

The replies and reactions of those polled relative to the point at which the individual would consider prophylactic neck dissection no longer justifiable on the basis of its chance of being of benefit were of considerable interest and significance. This question was formulated with the deliberate attempt of discovering the basis on which any individual had formed his opinion either for or against the procedure. Only sixteen of twenty three who favored prophylactic neck dissection were willing to make a positive statement by selecting a specific number. A few reacted in a curious manner in that they appeared to be opposed to any statistical basis for drawing conclusions on this particular question. Some preferred to "individualize" in each case by evaluating all factors, such as age, general condition, size and position of lesion, histological grade, and in some way to balance one against the other so as to arrive at a conclusion. Others would make a decision for or against prophylactic neck dissection on the specific size in millimeters of a given lesion, and one can only conclude that a difference of a millimeter one way or the other would provide the basis for their decisions. One of those who replied refused to be specific for the curious reason that he "could not measure the value of a human life on a statistical basis"—certainly an unrealistic and evasive attitude.

It can be seen from the above-mentioned discussion that there are those who resist any attempt to establish the practical value of therapeutic procedures on a sound statistical basis. They prefer rather to "individualize" and "to decide each case separately." It is apparent that such arbitrary decisions are largely a matter of the physician's state of mind and his optimism or pessimism as it may vary from day to day based upon the most recent experience. Such individuals hold that it is possible to make a decision by balancing and weighing a set of dissimilar factors. Even though some members of the medical profes-

sion should actually possess such occult powers to select treatment methods in individual cases without reference to, or regard for, statistical evidence, nevertheless, such skills are surely limited in their usefulness and could hardly be taught to others.

Regarding the exact figure at which prophylactic neck dissection would no longer be reasonable, the replies varied from "1 in 5" to "1 in 16." One surgeon stated that he would insist upon neck dissection in his own case for even the smallest cancer of the lip. Among those who specified a figure, the greatest number stated that they considered one in ten a sufficient incidence at which to employ prophylactic neck dissection.

On the basis of the submitted replies it appears, therefore, that the greater number (of those who treat mouth cancer) do not believe in prophylactic neck dissection and that a lesser number do favor the procedure. A majority of those who favor the procedure in all or in part of the cases state that one in ten is a reasonable incidence upon which to determine the indication of prophylactic neck dissection. If prophylactic neck dissection should be of theoretical benefit in one case in five then, as is indicated by our investigations, the latter group would favor the operation in all cases of cancer of the tongue. A few of the replies were completely illogical and fallacious in that the reasoning was as follows: Prophylactic neck dissection always results in a cure, and omission of such a neck dissection is invariably followed by death from cancer.

If Prophylactic Neck Dissection is Indicated in All Cases of Cancer of the Tongue, What Consideration Should be Given to Crossed or Bilateral Metastases? In none of the replies received was there any evidence that those who favored prophylactic neck dissection were aware of the frequent contralateral or bilateral character of cervical metastases in cancer of the tongue. For this reason, further investigations were carried out by the Department of Statistics at Memorial Hospital. It was established, thereby, that in cancer of the anterior two thirds of the tongue, the lesion crossed the mid-line in 21 per cent of the cases. In lesions that were distinctly unilateral and in which cervical metastasis eventually developed, in about 10 per cent the metastasis first appeared contralaterally. Furthermore, counting only the patients with cancer of the tongue in whom cervical metastases appeared at all, it occurred bilaterally in 24 per cent of the cases. Eliminating all duplications, the significant fact appeared that in 32 per cent of all cases of cancer of the tongue, the problem of treatment of cervical metastasis MUST APPLY TO BOTH SIDES OF THE NECK IF A POLICY OF PROPHYLACTIC NECK DISSECTION IS TO BE SERIOUSLY CONSIDERED AND ADOPTED. If this thesis, then, is carried to its logical conclusion, one must point out that all those who give one in ten as the basis for performing prophylactic neck dissection must, by their own process of reasoning, admit that in cancer of the tongue there is actually three times as great an indication for doing the operation bilaterally as (they would claim) for doing it at all.

Analysis of More Thoughtful Comments. If neck dissection is withheld until cervical metastasis becomes clinically evident (palpable), how much actual delay would there be? Several of the replies by those who were opposed to prophylactic neck dissection commented upon the significant fact that if the operation were delayed until the metastasis became palpable the delay in the majority of cases would not be more than a few weeks or a month provided, of course, that the patient was kept under close observation—a concept long maintained by Quick. This fact alone should relieve the uncertainty that should the operation not be done when the patient is first seen, it might not be done at all; or that any cervical metastasis that should subsequently appear would receive no treatment whatever. All those who are opposed to prophylactic neck dissection qualify this opinion by pointing out the absolute necessity for systematic follow-up observation. Obviously, such follow-up examinations are a part of the over-all management of the mouth-cancer patient, not only to discover any cervical metastasis as early as possible, but also to find and treat any recurrences in the primary site.

Many of those who favored prophylactic neck dissection admitted tacitly that their feelings were based in part on the fact that they could provide no systematic follow-up, either in their private practices or in their clinics. The performance of prophylactic neck dissection obviously cannot be considered an adequate substitute for such follow-up observations and as such cannot be used as a fair

argument for the procedure. Several of those who replied called attention to the fact that in their particular clinics there were a great number of indigent and illiterate patients who cannot be depended upon to co-operate in any follow-up plan; sometimes not even a single follow-up examination could be expected. In these instances, the argument was advanced that while the patient was in the hospital everything possible should be done to eradicate the disease completely since he could not be expected to return. It must be conceded that the latter argument is both logical and convincing for prophylactic neck dissection in such selected cases, but, nevertheless, that for reasons already given the operation, if performed at all, should be bilateral (preferably in two stages) in tongue cancer.

It is interesting to note that, among those who advocate the principle of prophylactic neck dissection, none stated that they would practice the operation routinely, and some of the strong proponents admitted that in many cases they would omit it entirely. As has been mentioned previously, most of those who favored individualization of the case were extremely vague and implied that one could balance logically such dissimilar and often unrelated factors as the patient's age and general condition, the size of the lesion, and the histological grading to arrive at a reasonable decision independent of any purely subjective, arbitrary, and prejudicial considerations.

A thoughtful review of the evidence for and against prophylactic neck dissection leads to only one sound conclusion, namely, that the performance or the omission of the operation must be considered as a calculated risk. The decision of individuals as regards calculated risks must obviously differ, and such differences of opinion do not necessarily reflect upon the individual intelligence. For example, even in this day and age an airplane flight, even on the best regulated of commercial flights, is considered by many to be more hazardous than travel by train. Nevertheless, persons of equal intelligence are divided in opinion. Some consider the risk of flight worth while on the basis of time and expense. Other equally intelligent persons refuse to take the risk and prefer to travel by train. It would be unfair to call one group more reasonable than the other, but it is fair to expect both to be logical and consistent. For instance, it would be illogical for a person to eschew the supposed risks of airplane travel but nevertheless to indulge in decidedly more dangerous activities, such as high ski jumping, mountain climbing, or automobile racing.

Here, a corollary can be made as regards prophylactic neck dissection. The clinician who feels that neck dissection should be performed on the basis of its being of theoretical value in one case in ten and the patient who accepts the procedure on this basis may be entirely logical in their reasoning. In cancer of the tongue, however, to be consistent, *the inevitable conclusion must then be accepted that the operation should be bilateral (usually in two stages)*; otherwise, to be reasonable, the procedure should be omitted or delayed until cervical metastasis becomes clinically evident.

At this point, the question arises as to whether bilateral prophylactic neck dissection (in stages) can actually be performed in all of those mouth-cancer patients who present no clinical evidence of the disease in the neck. In other words, no matter how fervently a clinician believes in the practice of prophylactic neck dissection, will he actually succeed in carrying it out consistently in a significant proportion of his cases? Furthermore, if he does succeed in doing so, will his over-all cure rate be superior to the figures obtained by those who do not follow such a policy?

On the Head and Neck Clinic of Memorial Hospital, the policy of routine prophylactic neck dissection is considered illogical and unacceptable. In cases in which it is needed, the operation (curative neck dissection) is not often delayed appreciably if the patients are followed closely for evidence of palpable disease. An analysis of the data presented in this survey indicates that prophylactic neck dissection for cancer of the tongue (to be logical and consistent) must necessarily be bilateral, therefore necessitating two hospital admissions, an interval of two or three weeks between operations, and a protracted hospital stay. A rigid routine of prophylactic neck dissection is hardly practicable, and it is doubtful that anyone can actually carry it out to a degree sufficient to effect any significant improvement in cure rates. Ledlie and Harmer in a recent report of 800 cases collected under the auspices of the Royal Cancer Hospital, London, state that the practice of prophylactic neck dissection has recently been given up.

In this discussion only cancer of the lip and

of the tongue have been considered. The problem of cervical metastasis and prophylactic neck dissection obviously applies similarly in other forms of mouth and pharynx cancer —floor of the mouth, mucosa of the cheek, gum, palate, tonsil, nasopharynx, pharyngeal wall, larynx, etc. In most of these anatomical forms of head and neck cancer it would be even more difficult to prove the justification for the operation.

Surgical Anatomy of Neck Dissection

A rational plan for the treatment of cervical lymph-node metastasis must be based upon a correct and reasonably thorough understanding of the detailed anatomy of the cervical lymphatics. The human lymphatic system has long been the subject of intensive study by many anatomists.[1, 2, 9, 30, 45, 57, 63] One of the most recent comprehensive treatises on the anatomy of the lymphatic system was published by Rouvière and contains a bibliography of almost 800 titles. Much of the controversy and confusion found in the literature on both the surgical and radiological treatment of cervical metastatic cancer is due not only to an inadequate knowledge of the anatomy of the lymphatics, but also to a paucity of dependable data regarding the clinical behavior of cervical metastatic cancer originating from various primary sites. The cervical lymphatics may be divided roughly into the superficial and deep chains.

The superficial lymphatics (or, rather, their collecting lymph vessels that drain the skin and its appendages) perforate the first layer of the cervical fascia to empty into the deep cervical lymphatic chain. The larger collecting trunks of the superficial lymphatics run on the posterior aspect of the platysma muscle accompanied by the external and anterior jugular veins. Although the lymph nodes of the superficial group are frequently involved by metastasis, especially during the later stages (usually by retrograde extension from the deeper lymphatics), these superficial lymph nodes are, nevertheless, of little significance from the practical standpoint of surgical treatment—the reason being that if invaded by cancer, they cannot in any case be removed completely by surgery except by excision of large areas of skin. Furthermore, when the superficial lymphatics are involved by cancer, the disease is almost always in an advanced and widely disseminated stage. For practical purposes, then, metastatic cervical cancer to be curable by surgery must be confined to the deep cervical lymphatic chain alone.

The deep cervical lymphatics are significant from the clinical standpoint, since they receive the lymph from the mucous membranes lining the mouth, pharynx and larynx, and the true glandular organs (the major salivary glands, thyroid gland, etc.), as well as from the skin of the head and neck. In general, the deep cervical lymphatics accompany the internal jugular veins and their branches or lie upon or within the major salivary glands. The most important of the deep cervical lymphatics are those of the internal jugular chain, which begins at the level of the posterior belly of the digastric muscle and extends along the walls of the internal jugular vein down to its entry into the subclavian vein behind the sternoclavicular joint; at this level, the lymph enters the venous circulation (the thoracic duct on the left side, the lymphatic duct on the right). The deep cervical chain consists of a network of lymph vessels interspersed with lymph nodes normally varying in size from a few millimeters up to 1.5 to 2 cm. These nodes lie mainly on the anterior,

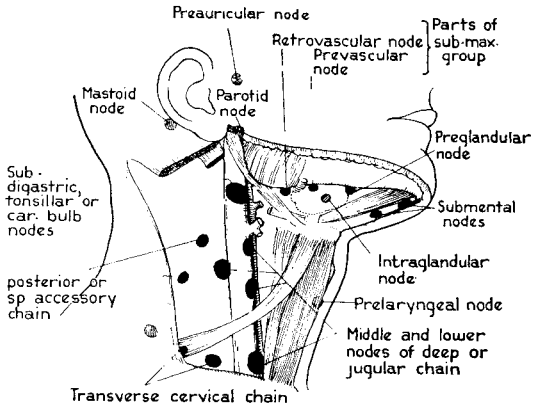


FIG. 1. The cervical lymphatics. The deep cervical lymphatic chain (accompanying the internal jugular vein and its branches) is clinically significant because it drains the lymph from the mouth, pharynx, and larynx and the TRUE GLANDS of the neck (the major salivary and thyroid glands). The upper and lower limits of the internal jugular chain of lymphatics are of practical significance, since between these two levels it is possible to section the internal jugular vein and remove it together with the accompanying lymphatics, thus establishing an anatomical basis for a surgical cure in the treatment of cervical metastatic cancer.

posterior, and lateral aspects of the internal jugular vein. Just below the level of the posterior belly of the digastric muscle there is a group of nodes, the largest of which is sometimes referred to as the "principal subdigastric node" and which is more frequently involved by metastatic cancer than any other site in the neck. In general, this group of nodes is conveniently designated as the SUBDIGASTRIC GROUP (Fig. 1).

From the standpoint of applied anatomy, it is significant that the internal jugular chain of lymphatics (deep cervical chain) extends no higher than the posterior belly of the digastric muscle and no lower than the clavicle. The definitive upper and lower limits of the internal jugular chain of lymphatics are of practical importance in neck dissection, since between these two levels it is possible to section the internal jugular vein and remove it together with the accompanying lymphatics, thus establishing an anatomical basis for a surgical cure. The lymphatics of the internal jugular chain are in close association with the walls of the vein itself, and it is unlikely that any procedure short of excision of the vein can completely remove the lymph vessels and nodes in this region. Practically all the lymphatics draining the tissues of the head and neck empty eventually into the internal jugular chain before entering the thoracic and/or lymphatic ducts. A discussion of the relative importance of the subsidiary lymphatic chains and node groups follows:

Submental Nodes. On the surface of the mylohyoid muscle, between the anterior bellies of the digastric muscles, lie at least two pairs of so-called submental nodes that drain the superficial tissues and skin of the lower lip, the chin, and, in part, the mucous membrane of the mid-portion of the lower lip. Although anatomists state that these nodes also receive lymph drainage from the floor of the mouth and the tip of the tongue, it is questionable whether this observation is accurate as judged from the clinical standpoint. These nodes are apparently not involved first in cancer of the floor of the mouth or tip of the tongue and only seldom in the more advanced stages of oral cancer, when, by retrograde or direct extension, metastasis may occur to the submental nodes even from such remote areas as cancer of the tonsil. Rarely, metastasis may appear first in the submental nodes in cancer of the mucous membrane of the lower lip; but nevertheless, cancer of the lip is more likely to metastasize first to the submaxillary nodes or to the upper deep cervical nodes. These clinical observations are of considerable importance in the treatment of lip cancer and cast considerable doubt on the logic of the oft recommended "anterior neck dissection" or "bilateral suprahyoid dissection" for cancer of the lower lip.[34]

Submaxillary Lymph Nodes. In the submaxillary area there are essentially three sets of nodes (preglandular, intraglandular, and pre- and retrovascular) that, in general, drain the mucosa of the lower lip, the cheeks, the gums, the floor of the mouth, the anterior portions of the tongue, and then empty into the deep cervical chain (Fig. 1). The respective nodes in the submaxillary group will be considered separately under the following headings:

1. PREGLANDULAR SUBMAXILLARY NODE. This node lies on the anterior aspect of the submaxillary salivary gland and may be involved first by metastasis from primary sites in the anterior portions of the mouth.

2. INTRAGLANDULAR SUBMAXILLARY NODE. This node lies within the substance of the submaxillary salivary gland and helps to drain the floor of the mouth and mid-portion of the tongue. Although not the most frequently involved early in metastatic cervical cancer, its presence constitutes one of the reasons for routine removal of the submaxillary salivary gland during neck dissection. (Rouvière refers to this node by the term "intracapsular." We feel that the term "intraglandular submaxillary node" is more definitive.)

3. PRE- AND RETROVASCULAR NODES. These nodes lie respectively just anterior and just posterior to the external maxillary artery and anterior facial vein at the lower edge of the mandible. This group of nodes is more often the first to become involved by metastatic cancer from a lesion in the mouth than any other node in the submaxillary group.

Spinal Accessory Chain. This group of lymphatics begins beneath the upper end of the sternomastoid muscle and runs downward and backward following the course of the spinal accessory nerve. From the standpoint of metastasis, the spinal accessory lymphatics receive drainage mainly from the nasopharynx

but, in its upper portion, it communicates with the internal jugular chain. Below, the spinal accessory chain turns forward into what is called the transverse cervical chain (accompanying the transverse cervical vessels) to join the internal jugular chain of lymphatics at the root of the neck. The complete removal of the spinal accessory lymphatics necessitates excision of the sternomastoid muscle and spinal accessory nerve as well as the extension of the dissection posteriorly to the anterior border of the trapezius muscle.

Parotid Lymph Nodes. There are several nodes that lie on and within the capsule of the parotid salivary gland. The most important of this group are those situated just in front of the tragus of the ear—often referred to as the "preauricular lymph nodes." These nodes drain the skin of the upper portions of the face, scalp, the eye (partially), and the mucosa of the upper lip. The lower parotid nodes lying in the region of the lower pole of the parotid gland may be involved secondary to the preauricular nodes, or they may be involved first in cancer of the upper lip, and frequently in cancer of the parotid salivary gland.

Miscellaneous Lymphatics. There are, of course, many details of the anatomy of the cervical lymphatics that have been omitted from the foregoing discussion. Some of these nodes are not surgically accessible, others are inconstant and variable, and there are still others that are seldom involved by metastatic cancer.

For all practical purposes, the lymphatics that drain those portions of the mucous membrane of the upper respiratory and upper alimentary tracts from which malignant tumors most commonly arise lie between the first and third layers of the deep cervical fascia, that is, between the undersurface of the platysma and the fascia overlying the prevertebral muscles and brachial plexus. For the most part, these lymphatics lie in close proximity to the larger veins and on or within the major salivary glands. Surgical cure of cervical metastasis is made possible only by an operation that includes the widest possible excision of these lymphatics and adjacent structures. The extensiveness of the procedure, however, should be compatible with reasonable function and comfort and should not be attended by a significant mortality rate. In brief, neck dissection should include the removal of all anatomical structures that can be sacrificed between the undersurface of the platysma and the third layer of the deep cervical fascia, from the inferior border of the mandible to the clavicle and from the anterior edge of the trapezius to the mid-line of the neck.

In carrying out this dissection, there are several important structures that must be preserved if at all possible. These are the common and internal carotid arteries, the vagus nerve, the brachial plexus, and to a lesser degree, the phrenic, hypoglossal, and lingual nerves and the cervical sympathetic chain. All other structures running through the operative field can be sacrificed with impunity.

There are several anatomical structures that may be inadvertently injured during the course of the operation. The frequency and gravity of the complications incident to injury of these will tend to be reduced with the experience of the individual surgeon and with the degree of his knowledge of the anatomy of the neck. These complications will be discussed separately and in detail elsewhere in this report.

Technique of Neck Dissection

In the following text and illustrations dealing with operative technique for neck dissection, the discussion will be limited to the procedure already defined as radical neck dissection. Any description of what has been referred to as partial neck dissection will be omitted since a description of the latter would, of course, be extremely variable and hardly capable of standardization. In our opinion, there can be little justification for the use of such limited operations in the treatment of cervical metastatic cancer.

Preoperative Preparation. Where complete responsibility is assumed for the cancer patient, the preoperative medical work-up will resolve itself mainly into an investigation for the purposes of discovering any systemic abnormalities which might be corrected or improved so as to prevent or minimize postoperative complications. The general attitude toward such preoperative study was expressed by the late Jules Abels as follows: "There are no *medical* contraindications to cancer surgery." This is an entirely reasonable policy, since the main disease (cancer), itself,

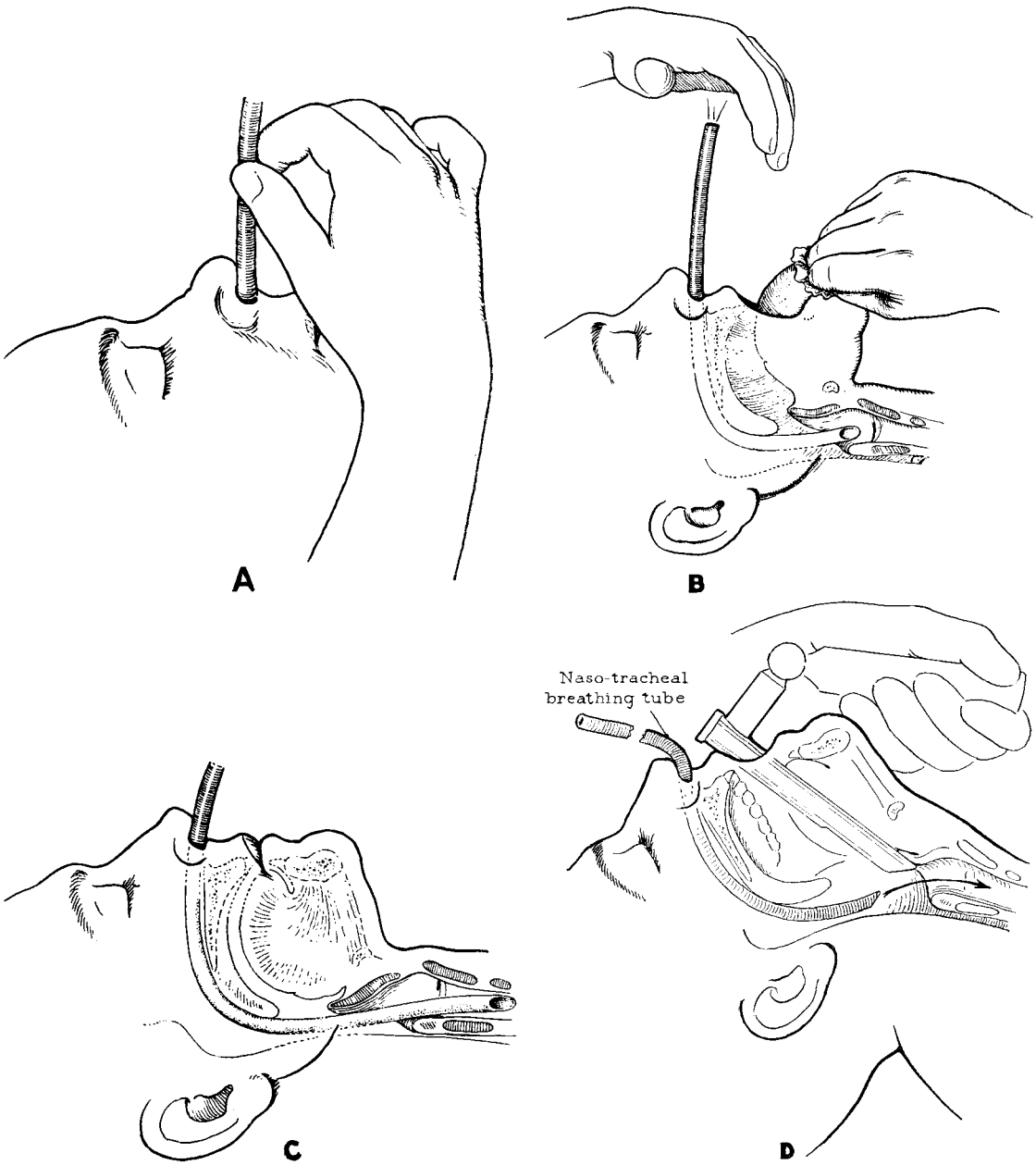


FIG. 2. Anesthesia for neck dissection: insertion of endotracheal tube. In most cases the nasotracheal breathing tube can be inserted blindly (A, B, C). Occasionally the laryngoscope must be employed, and the breathing tube guided through the glottis under direct vision (D).

is always fatal if untreated. If surgery offers the best chance of cure, then it is surely more reasonable to accept the operative risk rather than inevitable death from uncontrolled cancer.

Preoperative medical investigation of patients who are candidates for neck dissection or any other extensive surgical procedure should be placed in the hands of an internist with the understanding that he is to decide when the operation had best be done from the medical standpoint, rather than if it should be done at all. Such medical work-up will obviously include a thorough investigation of the cardiovascular, renal, pulmonary, hemopoietic systems, etc.

Anesthesia. Before the advent of sodium pentothal anesthesia, local anesthesia was the method of choice for neck dissection. Inhalation or rectal anesthesia (ether, avertin, etc.) were attended by many complications often resulting fatally. While it is entirely feasible to perform radical neck dissection under local anesthesia with a minimal degree of pain, the procedure is time consuming, requiring careful attention to infiltration of the lines of incision and painstaking blocking of the larger nerve trunks. Furthermore, the fully conscious patient must lie on the operating table for several hours.

In administering intravenous sodium pentothal for an operation in the head and neck, it is essential that an adequate airway be provided, either by endotracheal intubation or by performing a tracheostomy. It cannot be too strongly emphasized that sodium pentothal is a hazardous anesthetic in head and neck surgery without such provision for an airway, since laryngeal spasm and asphyxia may occur, particularly during induction or in the recovery stage. Usually the endotracheal tube is inserted through the nasal cavity down through the glottis after topical application of cocaine to the nasal cavity, pharynx, and larynx. While in most cases the experienced anesthetist should be able to introduce such a tube through the glottis blindly without the use of a laryngoscope, it is obviously more desirable to intubate the patient after he is asleep. With the pentothal-curare technique, intubation may be carried out after the patient has first been rendered unconscious with pentothal and the vocal cords relaxed with curare. Supplemental nitrous oxide and oxygen may be administered through the endotracheal tube or the tracheostomy tube. (Fig. 2.)

Blood Transfusions and Intravenous Fluids. Since the anesthetic is administered intravenously, blood transfusions during the operation may be given through the same single venipuncture. A pint of blood and one of normal saline are both attached to a single infusion needle, and the pentothal mixture (2.5 per cent) is administered by intermittent injections through the rubber tubing. Blood transfusions are given throughout the operation; about 1000 cc. of blood is employed in the average case.

Type of Incision. Many types of incisions have been used for neck dissection, some of which are either inadequate or too elaborate.[6, 15, 28, 34] The simplest form of surgical incision after the straight linear or single curve variety (neither of which provides for sufficient exposure for neck dissection) is the trifurcate or Y incision in which the angles of the skin flaps are all obtuse (about 120 degrees) rather than acute. To expose the operative field adequately for neck dissection, a double Y rather than a single Y incision may be made (Fig. 3). This is the simplest and most satisfactory form of incision possible of standardization. The Y incision, either single or double, with slight modifications can be used for any type of extensive operative procedure in the neck, and except for the single straight incision, any other form need hardly ever be considered.

Thickness of the Musculocutaneous Flaps. As has been mentioned under the discussion on the anatomy of the lymphatics, any surgical procedure capable of curing cervical metastasis must remove all the deep lymphatics from the mandible to the clavicle. If the superficial lymphatics are involved, such metastasis is ipso facto incurable by surgery except in rare instances by wide excision of the skin. For this reason, the undersurface of the skin flaps should correspond to the undersurface of the platysma muscle over the areas where this muscle is present and beyond its borders at about the same level. Despite reports in the literature to the contrary,[12, 34] in the average case the development of the skin flaps without the inclusion of the platysma is frequently followed by necrosis of the edges of the flaps, poor wound healing, and uncomfortable scars because of the close attachment of the skin to the deeper structures of the neck.

Some surgeons[6, 35] recommend that the platysma should be removed because metastases have been found in this structure in certain cases. When metastases begin to diffuse throughout the superficial lymphatics, not only is the platysma muscle widely involved but also the subcutaneous fat, nerve sheaths, carotid vessels, prevertebral muscles, larynx, trachea, and esophagus. The additional removal of the platysma can contribute but little to the eradication of widely disseminated cancer.[15, 27, 28] The only exception to this general principle (inclusion of platysma in

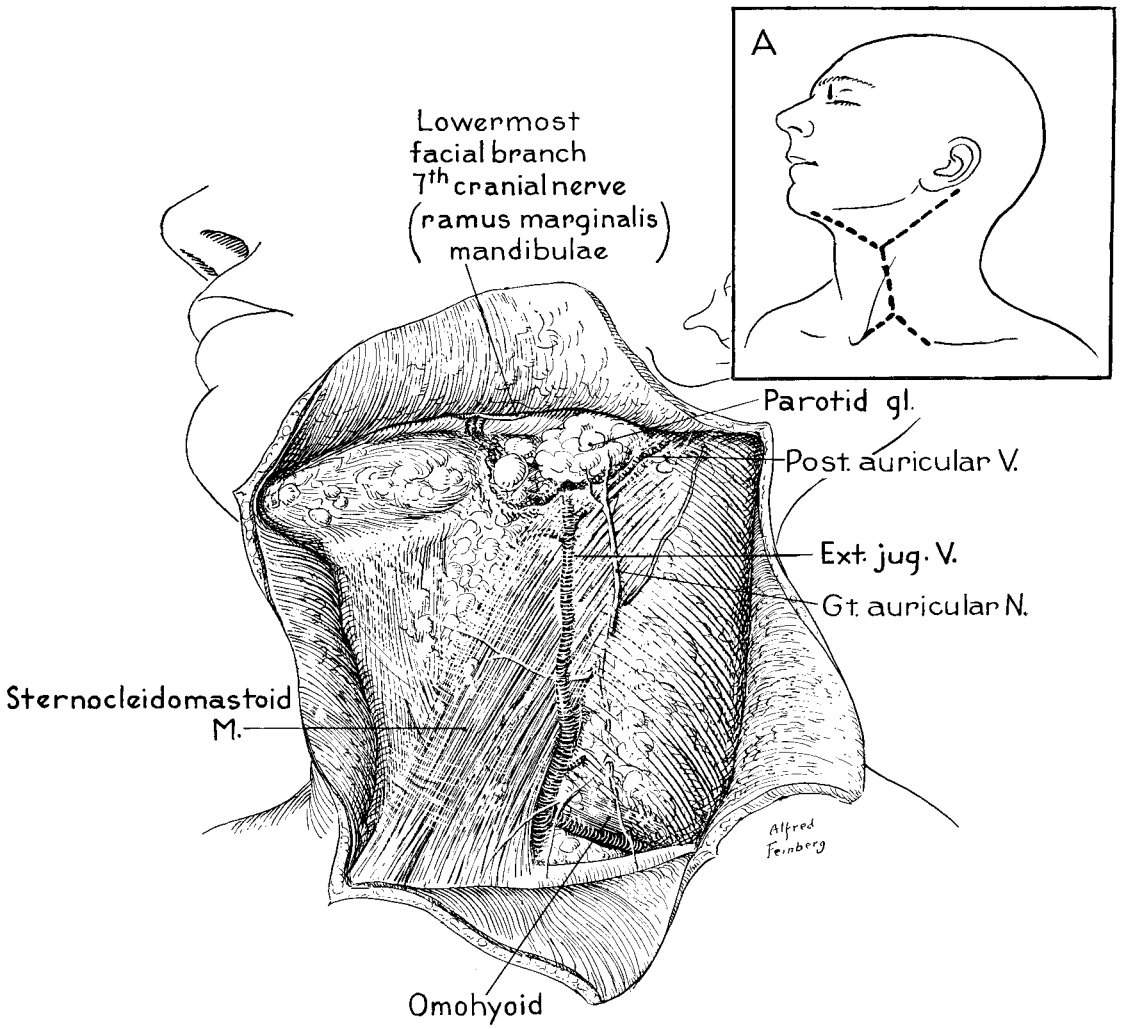


FIG. 3. Technique of neck dissection: incision and superficial skin flaps. The most useful form of incision for neck dissection is the double Y (double trifurcate), with wider extensions above than below. The line of dissection follows the undersurface of the platysma muscle, and beyond the border of this muscle at about the same level. The margins of the operative field are the lower edge of the mandible above, the mid-line of the neck in front, the anterior border of the trapezius muscle posteriorly, and the clavicle below.

the skin flaps) occurs in those cases in which a metastatic node in the deep lymphatics has become attached to or has infiltrated the outlying skin. In such instances the involved area of skin should be widely excised and left attached to the surgical specimen.

Ramus Marginalis Mandibulae of the 7th Cranial Nerve. In developing the upper or submaxillary flap, care should be taken to identify and preserve the RAMUS MARGINALIS MANDIBULAE, a branch of the facial nerve that provides the motor innervation to the lower lip of the corresponding side. If this branch is severed, a partial paralysis and deformity of the lower lip will occur. This nerve can be readily found (lying deep to the platysma muscle) as it crosses the external maxillary artery and anterior facial vein, just parallel to, and at the level of, the lower border of the mandible. (Fig. 4.) The cervical branch to the platysma given off just below the inferior border of the mandible may be sacrificed with impunity. From a practical standpoint, it is well to identify the RAMUS MARGINALIS MANDI-

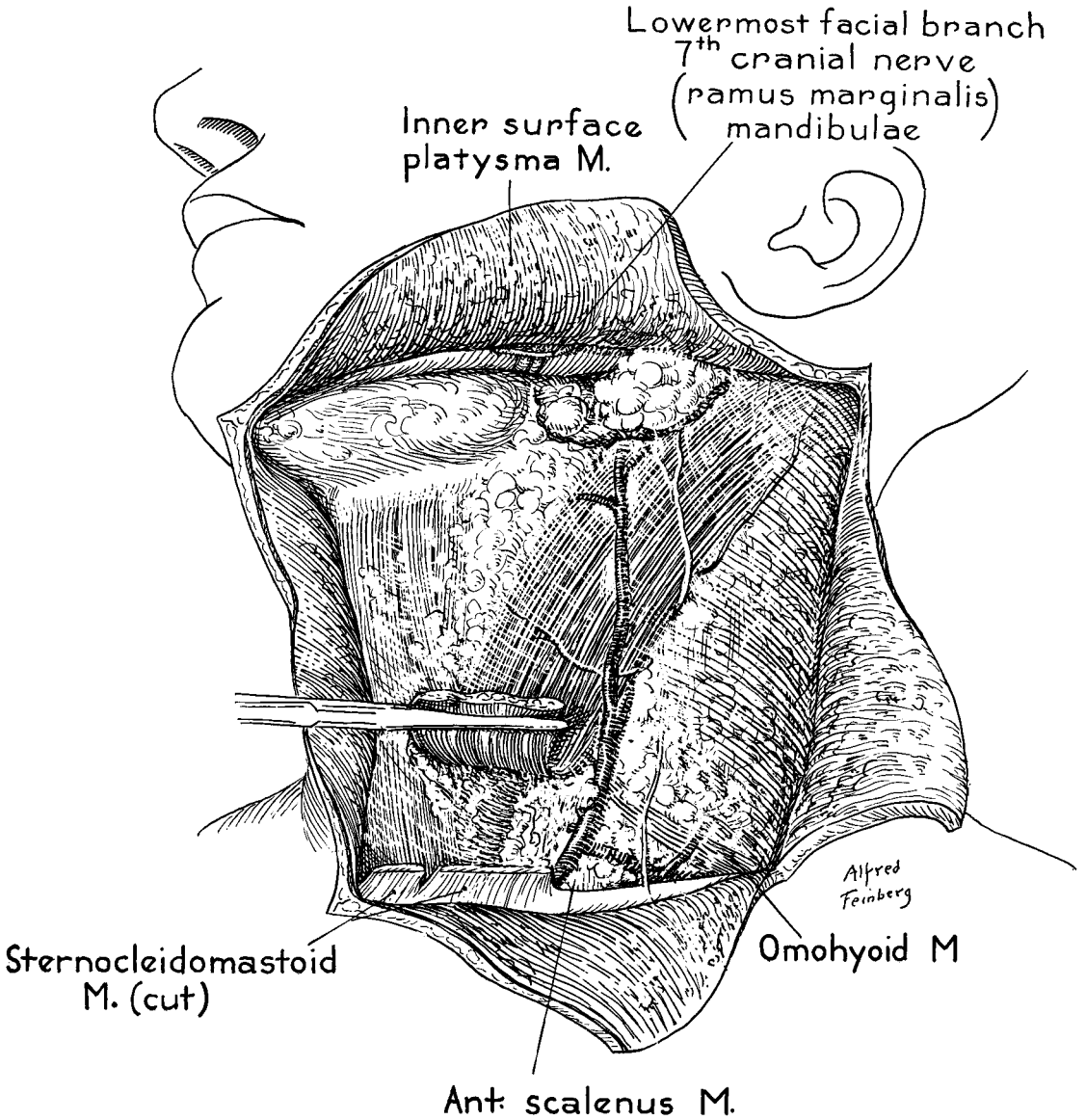


FIG. 4. Neck dissection: beginning the dissection below. Close to the external maxillary artery and anterior facial vein just about the lower edge of the mandible will be found the lowermost branch of the 7th cranial nerve. Unless this structure is identified and pulled aside, it will frequently be cut, and unilateral paralysis of the homologous half of the lower lip will result.

BULAE when the upper skin flap is being developed. After identification of the nerve, the external maxillary artery and anterior facial vein can be clamped, cut, and ligated, after which the upper end of the ligated vascular stump can be looped over the nerve and sutured to the upper skin flap for protection.

As will be shown later, the tail of the parotid salivary gland must necessarily be cut across and included in the surgical specimen, for only in this way may the upper end of the internal jugular vein be exposed just beneath the posterior belly of the digastric muscle. Resection of the tail of the parotid gland is not responsible for partial paralysis of the lip and injury to other branches of the facial nerve, as sometimes stated.[6]

Beginning of the Dissection. After reflecting the four skin flaps, the operation should proceed by severing the sternomastoid muscle

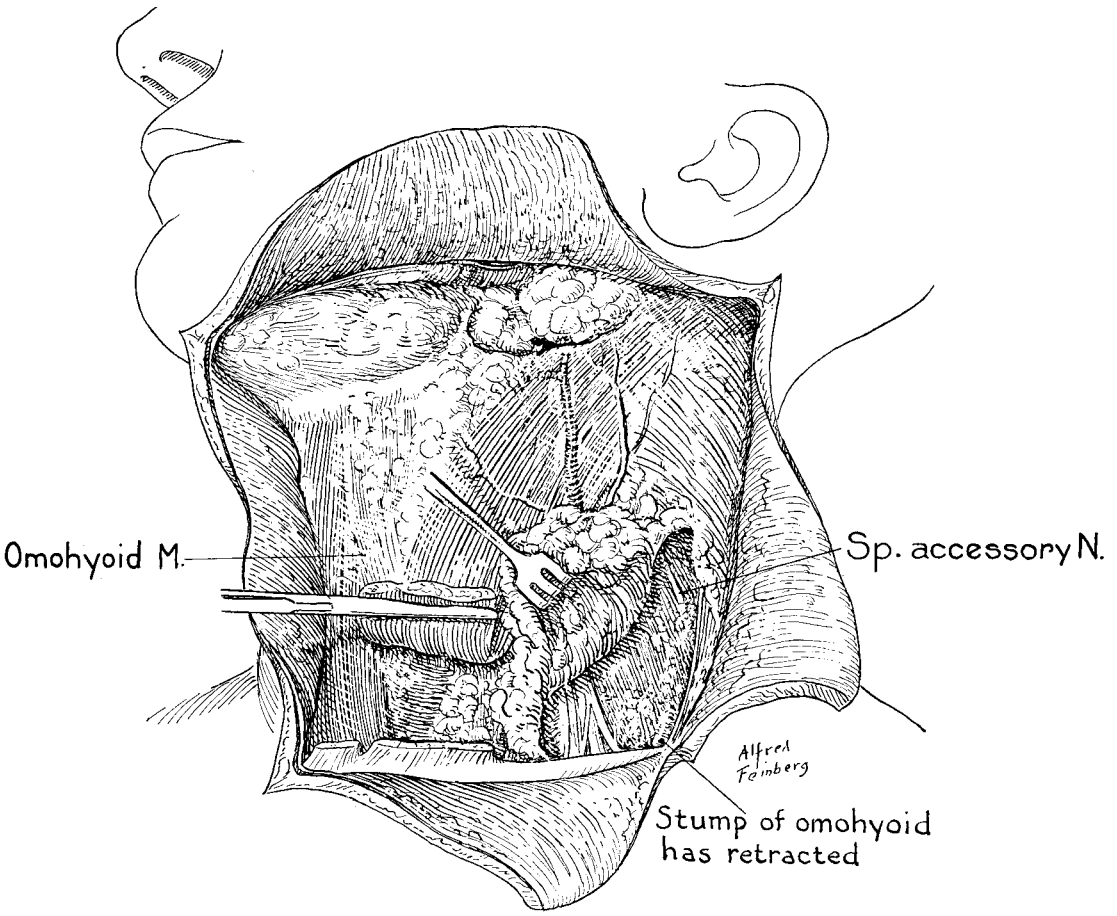


FIG. 5. Neck dissection: section of lower end of the internal jugular vein. The sternomastoid muscle is cut across just above the level of the clavicle, and the dissection then begins posteriorly severing the posterior belly of the omohyoid muscle.

at its insertion into the clavicle and sternum, after which no further dissection should be carried on in this particular area for the time being. (Fig. 4.) The dissection is then shifted to the lowermost portion of the posterior cervical triangle, with the scissors pointed toward the mid-line of the neck in a radial direction (parallel to the transverse cervical vessels and their branches). The anterior edge of the trapezius and the deep muscles of the neck are thus exposed (scaleni, levator angular scapulae, splenius capitis). (Fig. 5.) After clearing the areolar and lymphatic tissue in the posteroinferior aspect of the operative field, the dissection is carried forward just above the clavicle, proceeding mesially toward the region of the sternoclavicular joint.

Spinal Accessory Nerve. Although some surgeons maintain that the spinal accessory nerve should be preserved in every case,[12] the adequate removal of all areolar and lymphatic tissue from the posterior cervical triangle is not possible unless this nerve is sacrificed routinely. When the dissection is carried deeply along the lower half of the posterior cervical triangle, the nerve obviously will be cut somewhere along its course at this point, and there is no need to identify it.

The dissection is begun posteriorly, the immediate objective being to expose the anterior edge of the trapezius muscle. Several nerves will be encountered in this area emerging from the posterior edge of the sternomastoid muscle. All of these nerves are sensory branches of the cervical plexus (the great auricular, the cutaneous colli, and the supraclavicular nerves) except one motor nerve, which is the 11th cranial nerve. When the

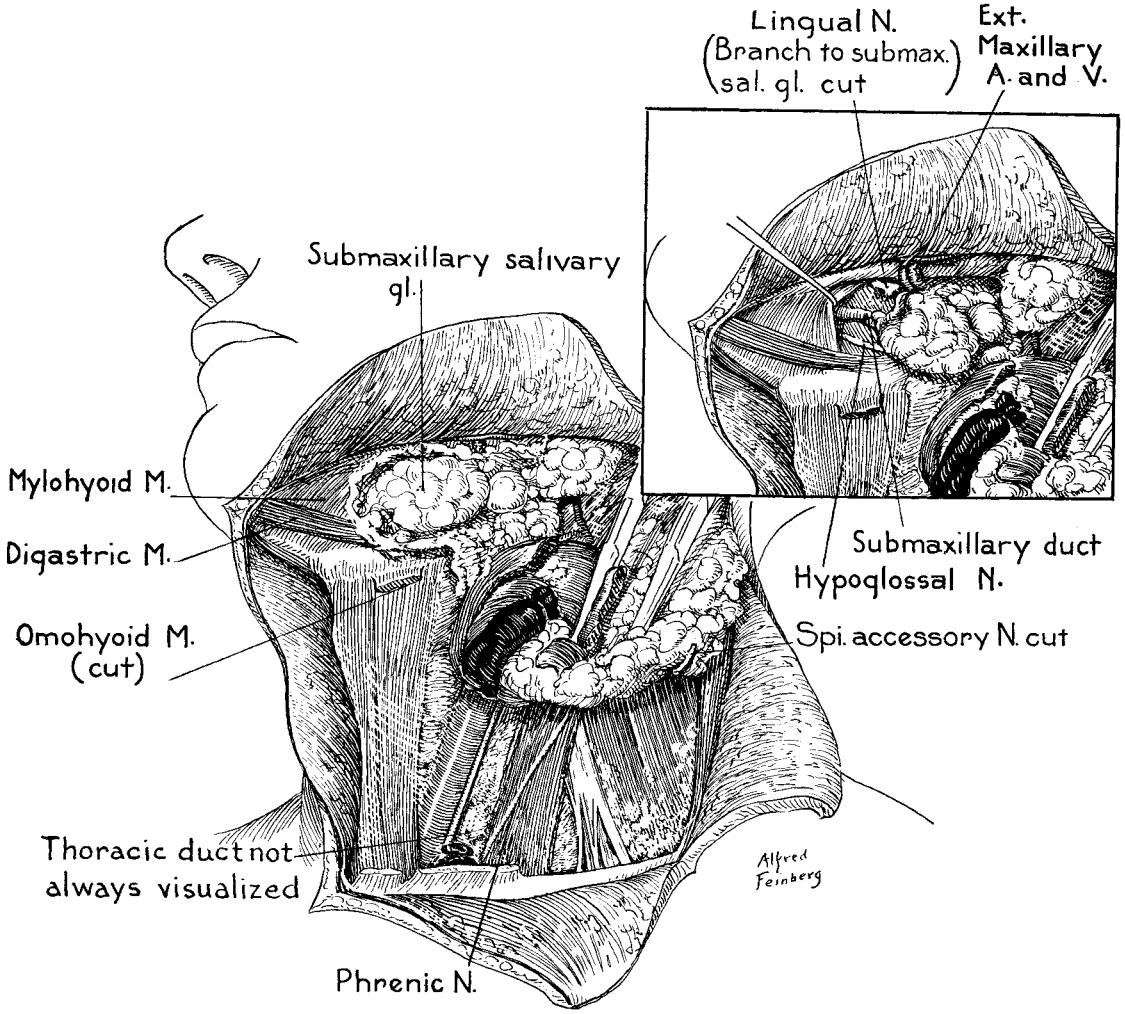


FIG. 6. Neck dissection: the submaxillary triangle. The dissection is carried down to the deep muscles of the neck (scalenae), severing the internal jugular vein just above the clavicle. Care should be taken to avoid injury to the phrenic nerve and (if the dissection is on the left side) the thoracic duct. The deep level of the dissection is the fascia overlying the strap and prevertebral muscles (third layer of deep cervical fascia). The 11th cranial nerve is sectioned at about the anterior border of the trapezius muscle. The common carotid artery, the vagus and phrenic nerves, and the trunks of the brachial plexus are exposed. The submaxillary salivary gland and the contents of the submaxillary triangle are removed down to the level of the mylohyoid and hyoglossus muscles.

latter is cut, there will be a definite spasmodic movement of the corresponding shoulder. The upper portion of this nerve then becomes a part of the surgical specimen, and it is not encountered again until the dissection is carried up to the lower edge of the posterior belly of the digastric, at which point the nerve is again seen emerging to join the hypoglossal and vagus nerves, the internal jugular vein, and the internal carotid artery.

Any technique that is designed to preserve the spinal accessory nerve should be condemned unequivocally. Naturally the nerve is of some, but not vital, functional importance. As is well known, the 11th cranial nerve comprises the motor innervation of the sternomastoid and the trapezius. When the spinal accessory nerve is sectioned, the function of shoulder elevation is not completely lost, since this action is taken over in part by the rhomboideus major and minor and the levator angular scapulae (dorsal scapular nerve).

There is, however, a fairly marked shoulder drop on the affected side which is sometimes noticeable even when the patient is dressed.

The determining factor in the decision to remove the 11th nerve routinely is that in its upper portion it runs directly through a mass of fatty areolar and lymphatic tissue in which are embedded the SUBDIGASTRIC NODES OF THE INTERNAL JUGULAR CHAIN—the most important of all lymphatic structures to be removed in neck dissection for cancer. After repeated observations of the surgical anatomy of this nerve in relation to the upper portion of the internal jugular chain of lymphatics, we are unalterably opposed to any attempt to preserve the nerve itself. The moderate disability following removal of this nerve will be discussed further under COMPLICATIONS.

Preservation of the Phrenic Nerve. The reason for advising the transection of the lower end of the sternomastoid muscle before proceeding with the dissection posteriorly is for the purpose of avoiding inadvertent injury of the phrenic nerve. In carrying the dissection forward just above the clavicle, there are several blood vessels and sensory nerves (transverse cervical artery and vein, supraclavicular nerves) that must be cut. It is essential, therefore, that the phrenic nerve, which lies on the fascia of the scalenus anticus, be kept in mind (Fig. 6). Otherwise, it is possible to carry the dissection beneath the phrenic nerve to raise it from its bed and cut it. If the phrenic nerve is severed, no serious complication occurs, although paralysis of the corresponding leaf of the diaphragm and consequent impairment of pulmonary ventilation may be followed by postoperative pneumonitis.

Dissection at the Root of the Neck. After having identified and preserved the phrenic nerve, the most painstaking and important stage of the operation is reached, that is, the approach to the level at which the internal jugular vein together with its accompanying chain of lymphatics is to be sectioned. (Fig. 6.) On the right side it is only necessary to remove the lowermost lymph nodes carefully in order to transect the vein without injuring the vagus nerve. On the right side the lymphatic duct is not usually identified, nor will any serious complication follow injury to it. On the left side, however, an important structure in this area is the main thoracic duct.

Thoracic Duct. The thoracic duct passes into the neck from the superior mediastinum and forms an arch at the root of the left side of the neck. This arch rises for a variable distance above the level of the clavicle and usually averages about 2 to 3 cm. in height. The thoracic duct runs from behind the common carotid artery to empty into the junction of the left subclavian vein with the left internal jugular vein, or it may empty directly into the internal jugular vein. Occasionally, several lymphatic vessels may enter the internal jugular vein separately, rather than as one main duct.

From the standpoint of surgical anatomy, the thoracic duct lies posterolateral to the common carotid artery and is embedded in a mass of loose areolar fatty tissue. The duct itself at this level, if visualized, appears as a thin-walled vessel with the contained chyle giving it a cloudy whitish appearance. In other cases the duct may present a varicose appearance, or there may be a plexiform interlacement of its many tributaries from the upper neck and mediastinum. In still others it may be so nearly the same yellow color as that of the surrounding fat as to be identified with difficulty.

The operation at this stage should consist of careful removal of the areolar tissue so that the main duct (or one or more of its tributaries) is not injured. If such an accident does occur, leakage of chyle slightly to highly milky in appearance will be noted. Should such leakage occur, an effort should be made to clamp and ligate the leaking points, employing nonabsorbable suture material (silk, cotton, nylon). Usually when the thoracic duct itself is opened there will be a discharge of highly milky fluid, and seldom will any complications ensue if the leaking point is carefully ligated. When the main thoracic duct is cut, a sanguineous flow is never obtained—a phenomenon that can be explained by the fact that a pair of valves is present where the duct terminates in the angle between the left subclavian and left internal jugular veins.

If it is necessary to ligate the main thoracic duct, no serious sequelae occur because drainage of the chyle is taken over by the right lymphatic duct and the many tributaries between the right and left ducts, both in the mediastinum and at the root of the neck. If permanent closure of the thoracic duct or one of its tributaries cannot be accomplished dur-

ing the operation, chylous drainage will appear postoperatively. Further discussion of this problem will be found under COMPLICATIONS.

Management of the Thyroid and Pharyngeal Venous Plexuses. Unless the surgical anatomy of the venous system of the neck is well understood, the management of this phase of the dissection will cause considerable difficulty and will be accompanied by unnecessary hemorrhage. In the anterior part of the dissection, a variable number of veins will be found crossing the operative field to enter the internal jugular vein, i.e., branches of the superior thyroid, lingual, superior laryngeal, and pharyngeal veins. With reasonable care these can be identified readily, clamped, cut, and ligated. When the upper level of the thyroid cartilage is reached, several relatively large veins will be found to emerge from the pharyngeal wall, cross the operative field, and enter the internal jugular vein. The dissection should proceed with care at this point, and the veins should be isolated individually, ligated, and cut as the operation proceeds.

Preservation of the Hypoglossal Nerve. The first portion of the hypoglossal nerve in the neck will be found to lie on, and parallel to, the course of the external and internal carotid arteries. The chance of injury to this structure is slight, since it lies rather high on the neck and can be easily identified and preserved. The nerve should be watched for, both as it emerges from behind the posterior belly of the digastric muscle about 1 to 2 cm. above the carotid bifurcation and in the submaxillary triangle where it is parallel and just inferior to the main submaxillary salivary duct. (Fig. 6.)

Clearing the Submental and Submaxillary Regions. In the submental area the anterior belly of the opposite digastric muscle should be exposed so that both of the paired submental nodes can be removed. Although these nodes are not highly important from the standpoint of metastatic cervical cancer, good technique requires their excision. As the submaxillary dissection proceeds (beginning anteriorly), the tissues are readily mobilized by severing the submaxillary salivary duct, which lies upon the hyoglossus and passes underneath the posterior edge of the mylohyoid muscle. In clearing this area no particular care need be taken to remove all of the tip of

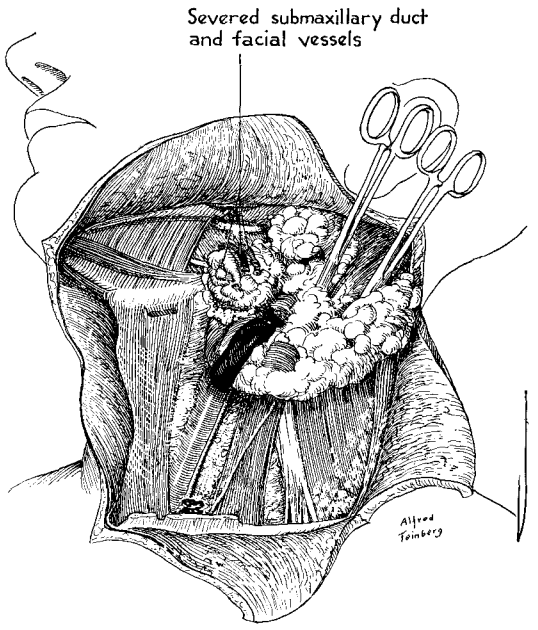


FIG. 7. Neck dissection: the submaxillary triangle. The external maxillary artery and anterior facial vein are sectioned at the level of the lower edge of the mandible, avoiding injury to the lowermost branch of the 7th cranial nerve (RAMUS MARGINALIS MANDIBULAE). The submaxillary duct is cut, but the lingual branch of the 5th cranial nerve and the hypoglossal nerve are preserved.

the deep portion of the submaxillary salivary gland, but the lingual branch of the 5th cranial nerve, which is intimately associated with the submaxillary salivary gland at this point, should be identified and preserved. (Fig. 7.)

The anatomical relations of the several important structures in the submaxillary triangle must be kept in mind if this phase of the operation is to be performed correctly. As the submaxillary salivary gland is grasped with a tenaculum and delivered from its bed, the posterior edge of the mylohyoid muscle comes into view and is retracted forward. At this point, three structures should be identified as they lie parallel to one another on the hyoglossus muscle and pass beneath the mylohyoid muscle; these are, from above downward, the LINGUAL NERVE, the SUBMAXILLARY SALIVARY DUCT, and the HYPOGLOSSAL NERVE. The only important structure in this area lying deep to the hyoglossus muscle is the lingual artery.

Subdigastric Dissection. As previously mentioned, the upper limit of the internal jugular chain of lymphatics is one of the most signifi-

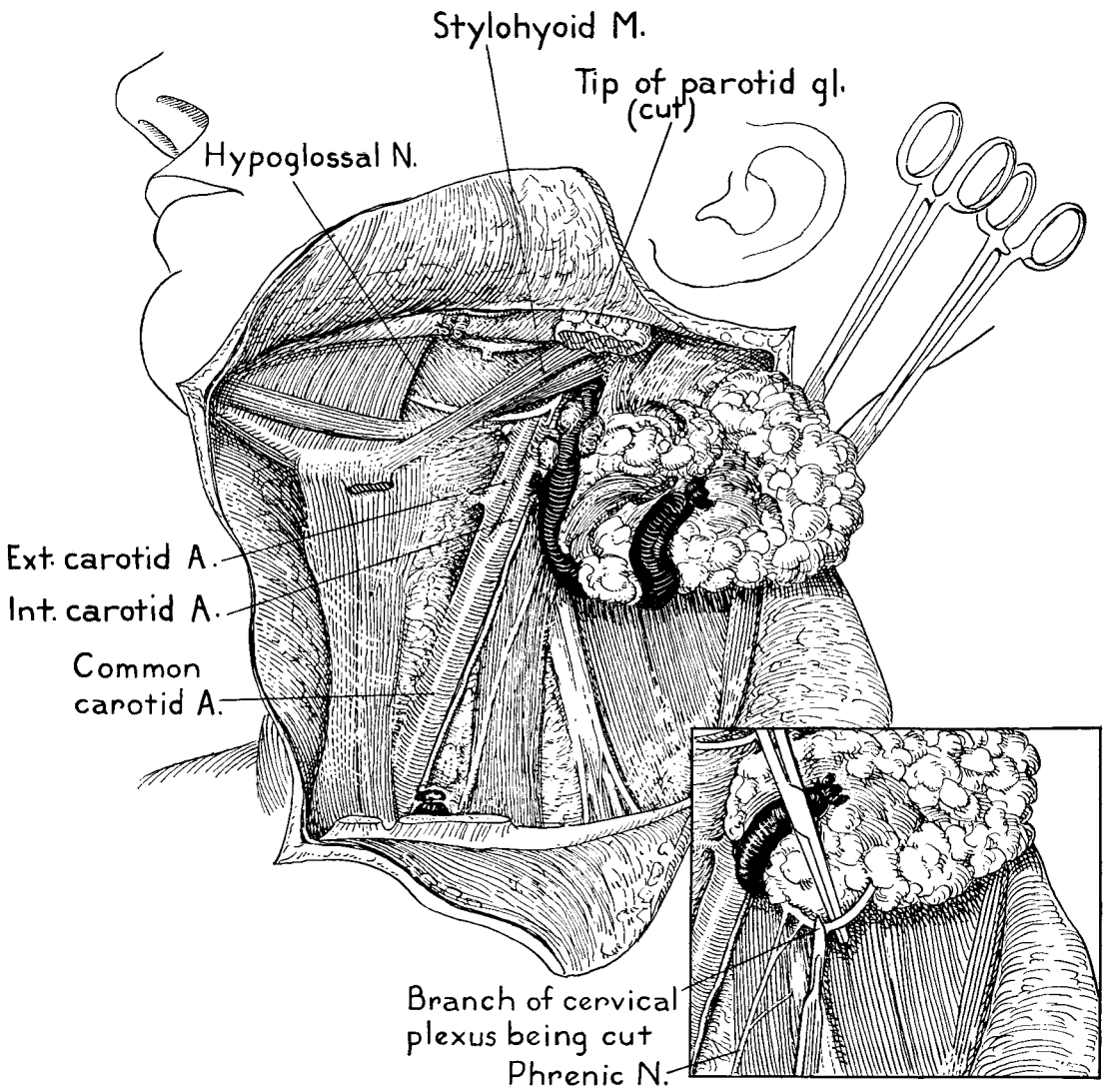


FIG. 8. Neck dissection: the subdigastric area. In the subdigastric area (below the posterior belly of the digastric muscle) is a mass of fatty and areolar tissue within which are found numerous lymph nodes most commonly involved by metastasis from oral and pharyngeal cancer. Within this mass of tissue are also found several vascular and nerve structures, including the 11th cranial nerve, which must be sacrificed in order that this area be effectively cleared. The 12th cranial nerve should be identified and preserved. The sensory branches of the cervical plexus are sacrificed.

cant levels in the morbid anatomy of cervical metastatic cancer. These nodes are most frequently involved first, and if the dissection in this area is not thorough, all the rest of the operation is useless.

The posterior belly of the digastric muscle is an important landmark during this phase of the operation, and it is well to expose the muscle along its entire course by cutting across the tip of the parotid salivary gland (Fig. 8). Retracting the posterior belly of the digastric and stylohyoid muscles upward, the dissection should then be carried down to a point where the upper end of the internal jugular vein can be isolated, clamped, cut, and ligated reasonably high above the muscle (Fig. 9). At this point in the dissection, the 11th cranial nerve is sectioned for the second time and included in the surgical specimen (Fig. 10).

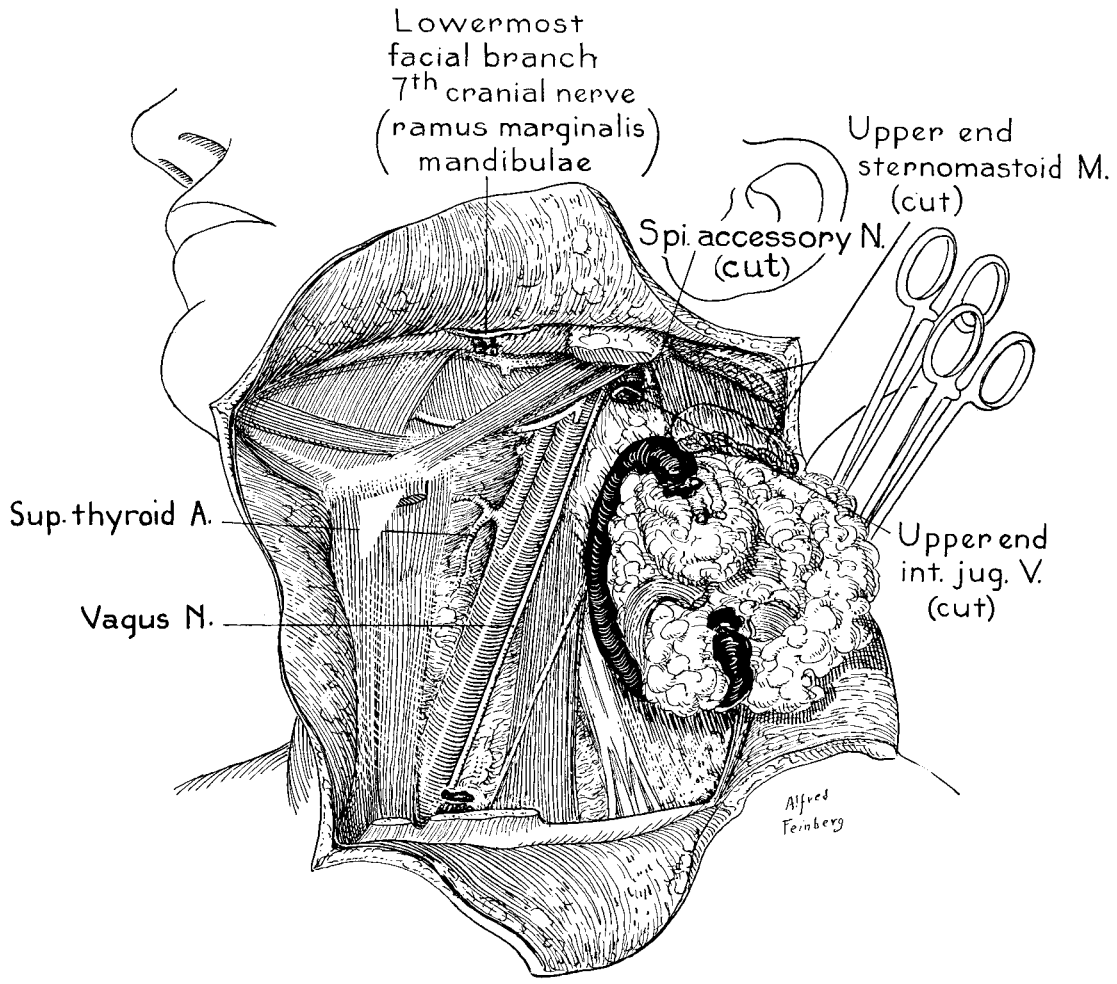


FIG. 9. Neck dissection: section of the upper end of the internal jugular vein. Nearing the end of the dissection, the upper end of the internal jugular vein is exposed just under the lower edge of the posterior belly of the digastric muscle. At this level the vein is clamped, cut, and doubly ligated.

The posterior belly of the digastric muscle (and the stylohyoid muscle) can be excised if it appears to be attached to the metastatic mass. Otherwise, mere upward retraction of the muscle will provide adequate exposure of this critical region. Several large veins in this area (common and posterior facial veins) must be secured in order to free the specimen at the angle of the mandible.

Wound Closure and Dressing. A long cigarette drain is loosely anchored with one absorbable suture to the posterior belly of the digastric or stylohyoid muscle, running downward to emerge through the anterior arm of the lower Y incision. This drainage is usually adequate, provided the skin incision at the lower end of the wound is left open for a distance of about 2 cm. A bulky pressure dressing should be applied so that the skin flaps are snugly and evenly opposed to the underlying tissues.

Tracheostomy. In some clinics tracheostomy is always employed at the completion of neck dissection.[65] In our opinion, such a routine practice is unnecessary and in certain cases may interfere with wound healing and increase the morbidity. Tracheostomy is indicated, however, in specific conditions, such as in the combined operation where the mandible is sectioned or partially resected. If the preoperative laryngeal examination reveals even slight edema of the arytenoids as the

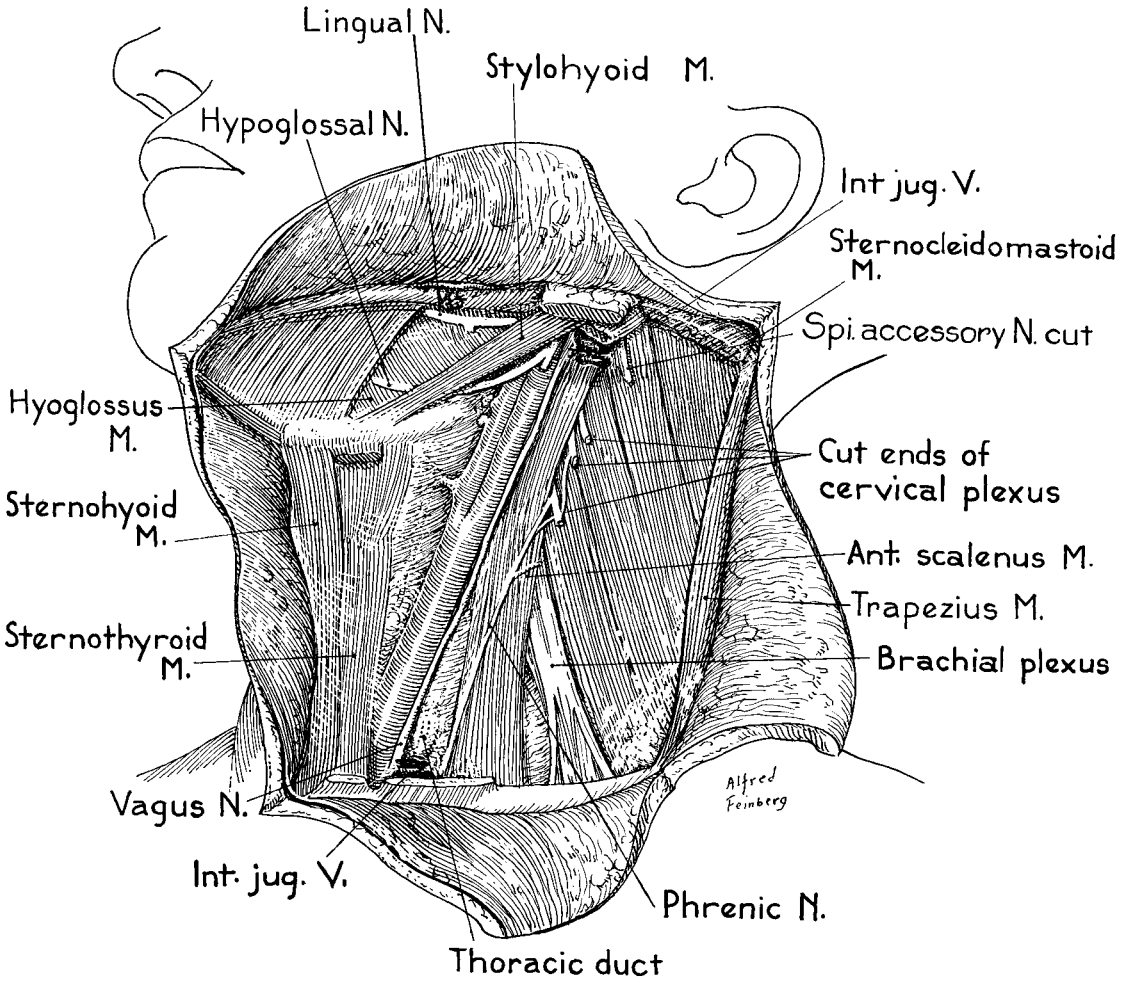


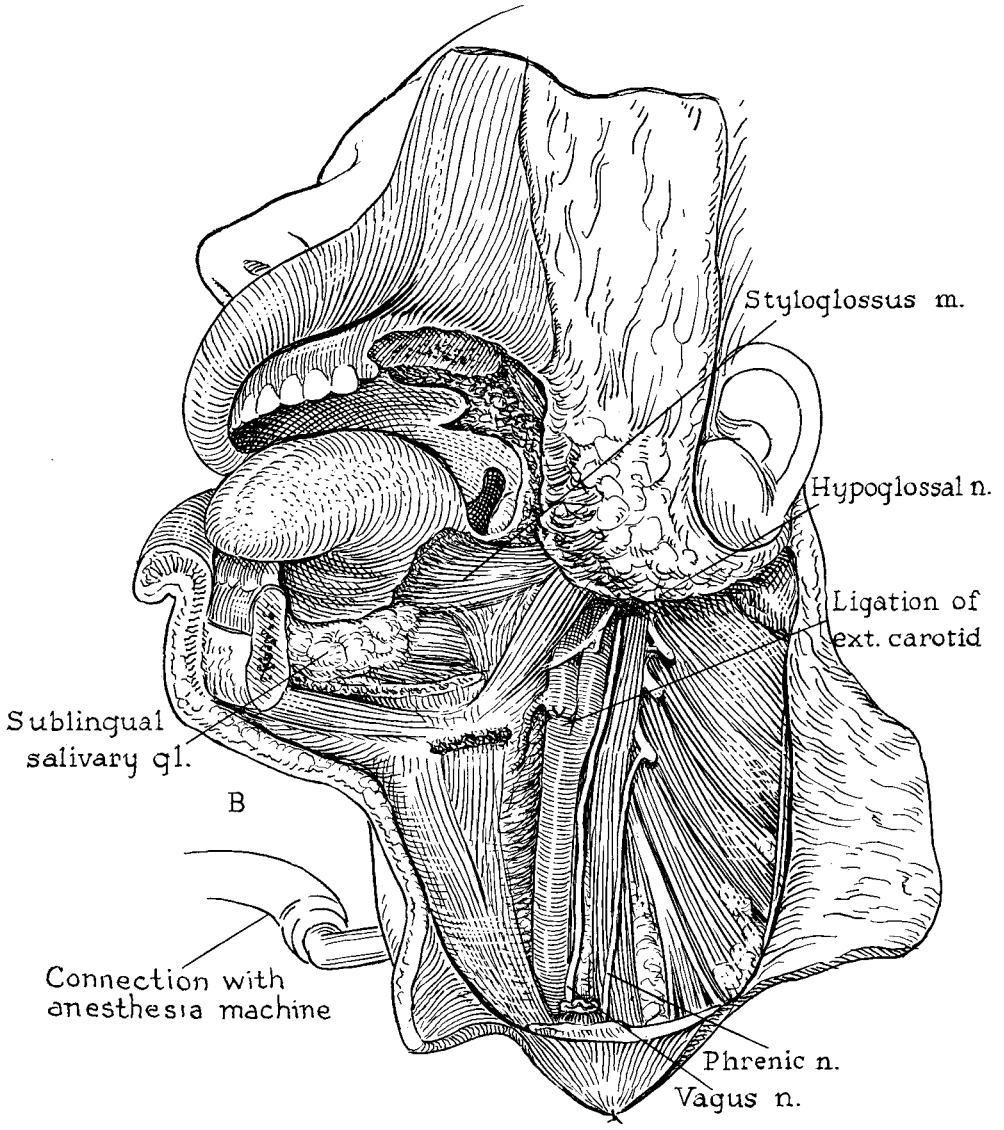
FIG. 10. Neck dissection: completed operation. In the completed neck dissection all lymph-node–bearing tissue between the undersurface of the platysma and the third layer of the deep cervical fascia has been removed, preserving only certain vital structures, which include, from above downward, the RAMUS MARGINALIS MANDIBULAE of the 7th nerve; the lingual, hypoglossal, vagus, and phrenic nerves; the brachial plexus; and the common and internal carotid arteries. The external carotid artery may be sacrificed if necessary.

result of previous radiation therapy or previous contralateral neck dissection, it is prudent to insert a breathing tube at the completion of the operation. The same is true if total thyroidectomy and neck dissection for thyroid cancer requires the section of both recurrent laryngeal nerves. This subject will be discussed further in the section on COMPLICATIONS.

VARIATIONS IN PROCEDURE OF NECK DISSECTION

Partial Neck Dissection. As previously mentioned, there is little justification for the use of the partial (submaxillary dissection, supraomohyoid dissection, neck dissection with omission of the submaxillary dissection, etc.) rather than the complete operation.

The exact technique of the so-called "supraomohyoid" neck dissection is seldom clearly defined by those who practice it. If one assumed that it was complete and thorough above the level of the omohyoid, then it would differ from the radical neck dissection only by failing to remove the lower third of the internal jugular vein and the lowermost nodes of the internal jugular chain. Just what would be gained by stopping at the level of the omohyoid rather than going down to the level of the clavicle is not clear, and for this



Figures 11 to 14 show neck dissection combined with excision of a primary lesion in the mouth and section of the mandible.

FIG. 11. After completion of the neck dissection (note ligation of external carotid artery for hemostatic purposes), the lip and chin are split in the mid-line and the cheek reflected laterally. The mandible is transected at the appropriate point and disarticulated; the surgical specimen includes the attached resected oral primary (gum, cheek, floor of mouth, tongue, etc.). In these cases, tracheostomy is performed routinely.

reason, the "supraomohyoid" neck dissection seems to us no more reasonable than to clear out only the lower part, rather than the whole axilla, in a radical amputation of the breast.

In our opinion the partial operation should never be used except for some unusual situation and then by a surgeon who is competent by experience to make the choice between the complete and partial procedures.

Removal of the Digastric Muscle. If indicated, both bellies of the digastric muscle may be excised without any significant functional disability. The determining factor is mainly whether or not such excision facilitates the removal of the disease in the more extensive cases.

Carotid Arteries. Most significant in determining the "operability" in doubtful cases

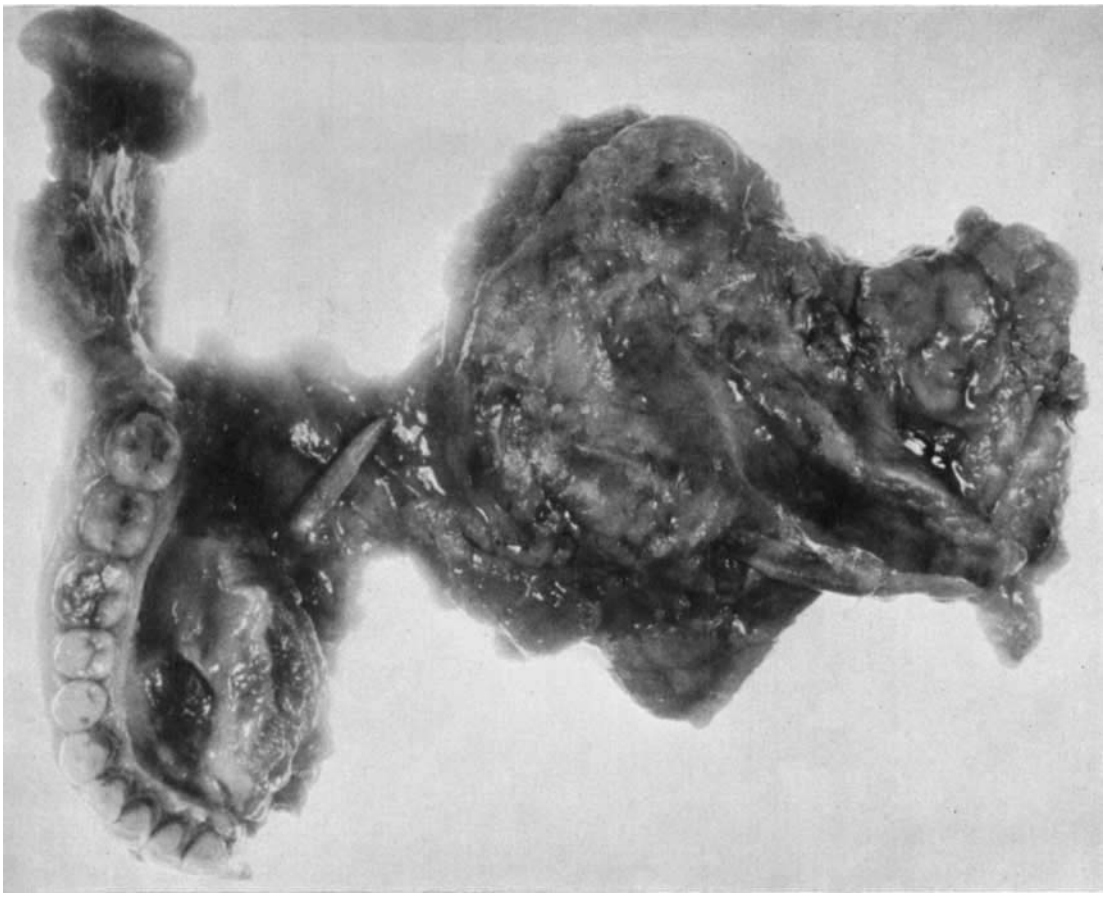


FIG. 12. Surgical specimen of the combined operation.

of cervical metastatic cancer is the question of invasion by tumor of the common or internal carotid arteries and the decision whether or not to remove one of these blood vessels in order to encompass all of the disease. Technically, the excision of the artery is not difficult, but the complications following interruption of this portion of the arterial circulation are serious. NO MATTER WHAT PRECAUTIONS ARE TAKEN EITHER BEFORE OR AFTER THE OPERATION, the postoperative mortality following interruption of the circulation in the common or internal carotid artery is between 40 and 50 per cent, either immediately or within the first few postoperative days. The decision that must then be made by the surgeon who finds a metastatic node attached to the wall of the common or internal carotid arteries is whether to risk the immediate high mortality or to accept the technical failure of leaving cancer behind at the completion of the operation. Thus far, no satisfactory solution for this problem has been found. In the older age group with a limited life expectancy, most of the surgeons on the Head and Neck Service at Memorial Hospital elect to leave cancer behind and to apply radiation therapy to the area containing residual tumor rather than risk the high mortality. In the younger age group in which life expectancy is normally longer, we often tend to risk the immediate high mortality, since the long-range chance of survival seems more worth while.

The external carotid artery is not a vital structure and may be sacrificed either on one or both sides without any untoward sequelae. During neck dissection if the growth is found to invade the external carotid artery this structure is, of course, removed with impunity, the only concern being that there should be sufficient remaining uninvaded stump for proper ligation so that the integrity of the lumen of the common carotid artery is maintained.

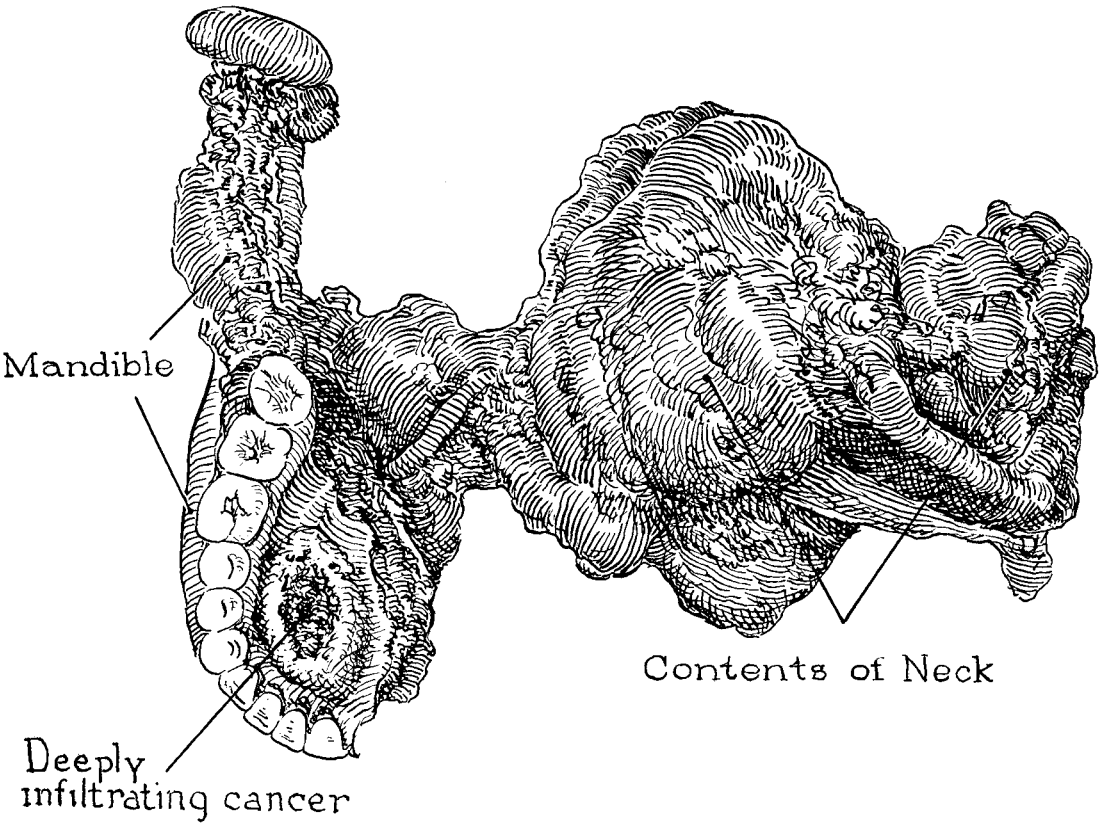


FIG. 13. Artist's drawing of the surgical specimen.

(It was formerly a common practice on the Head and Neck Service to perform bilateral ligation of the external carotid arteries as a preliminary step to extensive operations in the head and neck. This procedure reduces the vascularity of the operative field, and when performed bilaterally in one stage is perfectly safe and is never followed by any complications, either local or cerebral. No fear need be entertained that the local circulation may be reduced to a point where healing is interfered with.

Nevertheless, if such unilateral or bilateral ligations require separate incisions (that is, if the ligations cannot be done through the incisions already made as part of the operation), then the ligation is objectionable in that surgical scarring is produced at the most vital site as regards the treatment of any future cervical metastasis, either by surgery or by radiation therapy. For this reason, we have largely discarded the practice of prophylactic ligation unless the vessel is actually exposed in the operative field.

In ligating the external carotid artery, a permanent ligature [No. 32 steel wire] is preferable, since in many cases operation may be required at some later date and it may be desirable that the main arterial supply be permanently interrupted. The use of a radiopaque material like steel wire is further advantageous in that the neck can always be roentgenographed subsequently and the ligature demonstrated if there is ever any doubt whether or not carotid ligation has been performed in a given case.)

When neck dissection is performed in cases in which an oral primary growth had been previously treated with radiation therapy, it is prudent to ligate the external carotid artery as it lies exposed in the neck, since there is always the possibility that such a patient may subsequently develop radionecrosis at the primary site—a complication occasionally accompanied by hemorrhage sufficiently severe to require ligation of an external carotid artery.

Arterial Grafts. When the surgeon is faced with the necessity of excising the common or internal carotid artery in cases of metastatic cervical cancer, there will almost invariably be associated technical factors that preclude

FIG. 14. Photograph of a patient taken two months following the combined operation.

the successful use of blood-vessel grafts to re-establish the continuity of circulation.

Vagus Nerve. The vagus nerve alone is seldom invaded by metastatic cancer without an associated involvement of the common or internal carotid artery so that there is hardly any indication for sacrificing this nerve without sectioning these vital blood vessels. The aftereffects following section of the vagus nerve will be discussed further under COMPLICATIONS.

Hypoglossal, Lingual, and Phrenic Nerves. The morbid anatomy of cervical lymphatic metastasis is such that these nerves are seldom involved by disease and need only rarely be included in the dissection. In any case, these structures are not highly vital and if invaded by disease, any one of them may be sacrificed without any serious functional disability.

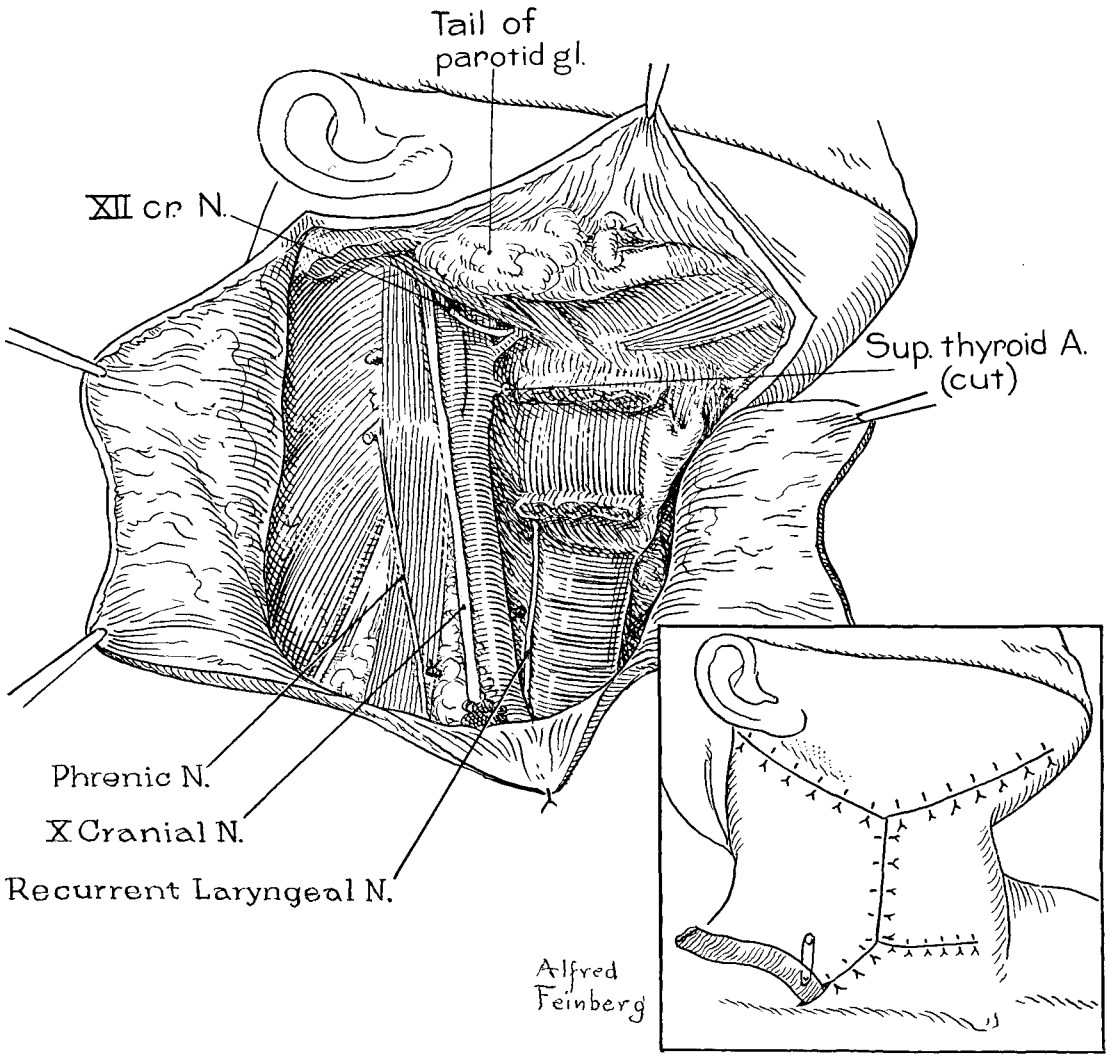
Combination of Neck Dissection with Excision of Adjacent Structures or Organs. Cervical metastases are frequently found on admission in patients with untreated or uncontrolled primary cancers in the following sites: mouth, pharynx, larynx, thyroid gland, and the parotid salivary and submaxillary salivary glands. In many of these cases both the primary site and the metastases in the neck are "operable" from the standpoint of complete removal by radical surgery. In these instances, neck dissection may be combined with disarticulation of one half of the mandible together with excision of the intraoral growth, or with thyroidectomy, or total laryngectomy, or resection of the parotid salivary gland (Figs. 11 to 25). Where such a combined operation is performed, the entire procedure is carried out in one stage and the surgical specimen is removed en bloc.

In most cases of thyroid cancer, it is advisable to combine neck dissection with hemithyroidectomy (including excision of all adjacent strap muscles). If total thyroidectomy is required, it is perhaps more prudent to do it in two stages; that is, two separate unilateral neck dissections plus homologous hemithyroidectomy. If, for any reason, the tissues of the neck have been scarred by previous surgery or heavy irradiation, it is not technically possible to perform so thorough a neck dissection as in the case of unscarred tissues. It is usually possible to remove thyroid cancer completely with preservation of the recurrent laryngeal nerve. Deliberate sacrifice of this structure, however, is indicated if the nerve is involved by the disease.

POSTOPERATIVE CARE

Operative deaths in neck dissection may occur on the operating table, but most of them take place during the immediate postoperative period and are often associated with INADEQUATE NURSING CARE. Since the operation is usually performed under general (intravenous pentothal sodium) anesthesia, a constant vigil must be maintained at the bedside until the patient is fully conscious. It should be kept in mind that following operation the neck is necessarily somewhat constricted by a bulky pressure dressing, and therefore carelessness or indifference in the positioning of the head may cause serious or even fatal obstruction to respiration in an unconscious patient. The position of the head is of less importance as long as an endotracheal tube is in place.

Management of the Nasotracheal Breathing Tube. When intravenous sodium pentothal requiring oral or nasal intubation has been used, the breathing tube should be left in



Figures 15 to 18 show neck dissection combined with thyroidectomy.

FIG. 15. In cases of thyroid cancer, neck dissection may be combined with excision of the homolateral lobe of the thyroid gland and all adjacent strap muscles. Note that the lower mesial angle of the incision runs horizontally as in the usual collar incision for thyroid operations. The recurrent laryngeal nerve is preserved if it is not involved by disease.

place until the patient has reacted to the point where he can remove the tube himself or at least is conscious enough to object to its presence. In the present series, some postoperative deaths have occurred from suffocation because of too early removal of the endotracheal tube and subsequent laryngospasm. Death may also be due to the fact that the unconscious patient has little muscular control, with the result that the tongue may obstruct the laryngeal opening. In our clinic it is now a routine practice not only to leave the tube in place, but to attach a special tag to the protruding end, calling attention to the fact that the tube is in the trachea, that no feeding is to be given through it, and that the endotracheal tube is to be left in place until the patient is conscious. This tube should be suctioned out frequently with a catheter.

Mouth Suction. Before and after removal of the endotracheal tube, the mouth and pharynx are kept clear by frequent suctioning using a metal (Yankauer) suction tip.

FIG. 16. Photograph of a patient taken one year following combined neck dissection and thyroidectomy for thyroid cancer (bilateral and in two stages).

When fully conscious, the patient is placed in a semisitting position and encouraged to cough. If the respiratory secretions cannot be voluntarily expelled from the pharynx, this material should be gently removed by suction.

Chemotherapy and Antibiotics. Therapeutic doses of penicillin are given daily until the temperature is below 100° F. In recent years it has become a routine practice to administer one million units of penicillin in a single dose immediately on return to the bed after all major head and neck operations. Regular daily dosage of penicillin in lesser amounts is then continued for several days. In those rare instances in which some unusual inflammatory condition occurs and in which penicillin does not seem effective (pneumonitis, parotitis, etc.), other drugs (sulfadiazine, streptomycin, aureomycin, etc.) may be prescribed as indicated. In the majority of cases, however, penicillin alone appears to be adequate.

Management of Nutrition. Following neck dissection there will always be some difficulty in swallowing. Even though the patient may be able to force down a fairly adequate liquid diet, nevertheless, his discomfort makes the routine introduction of a nasoesophageal feeding catheter advisable. When the patient is conscious, the tube is inserted blindly through the nasal cavity down into the pharynx. With experience it is not too difficult to determine whether or not the catheter has actually entered the esophagus. Should the feeding tube be in the glottis the patient will usually cough violently; it is accordingly partly withdrawn and reinserted until it enters the esophagus.

In a small proportion of patients, the entry of the catheter into the trachea may not be followed by any immediate reaction. It is therefore prudent, whenever possible, to test the position of the catheter by mirror examination of the hypopharynx. If the catheter is seen to lie along the lateral pharyngeal wall, one may be certain that the tube is in the pyriform sinus and therefore in the esophagus (Fig. 26). When the catheter is definitely seen to lie in the mid-line, one may be reasonably certain that the tube has been inserted through the glottis and is in the trachea even though the glottis itself cannot be visualized at the time. In the conscious patient, a drop or two of Dakin's solution may be introduced through the feeding tube, and if this solution enters the trachea, vigorous coughing will follow. Should there be no reaction to the Dakin's solution then 1 or 2 cc. may be introduced through the tube, and, if the patient continues to remain quiet, one may feel assured that the feeding tube is definitely in the esophagus and not in the trachea.

When the nasoesophageal tube has been properly placed, it is taped to the skin of the nose, and, since postanesthetic nausea is rare following pentothal, the administration of fluids is started immediately, due attention being paid to nutritional and vitamin requirements. The tube may be left in place for three or four days or longer, or it may be withdrawn and reinserted before each feeding. Whenever the patient appears to be able to swallow without appreciable discomfort, the tube is withdrawn and oral feedings are begun.

Ambulation. Early ambulation of patients following operation has been an important factor in the reduction of postoperative morbidity and mortality, especially in elderly individuals. With local anesthesia, and especially with intravenous sodium pentothal, there is so little postoperative morbidity that, even after a five- or six-hour operation, a patient will have reacted so completely that he may be got out of bed and allowed to walk about on the first postoperative day. On the Head and Neck Service at the Memorial Hospital, all patients who have been subjected to operations about the head and neck, even the most

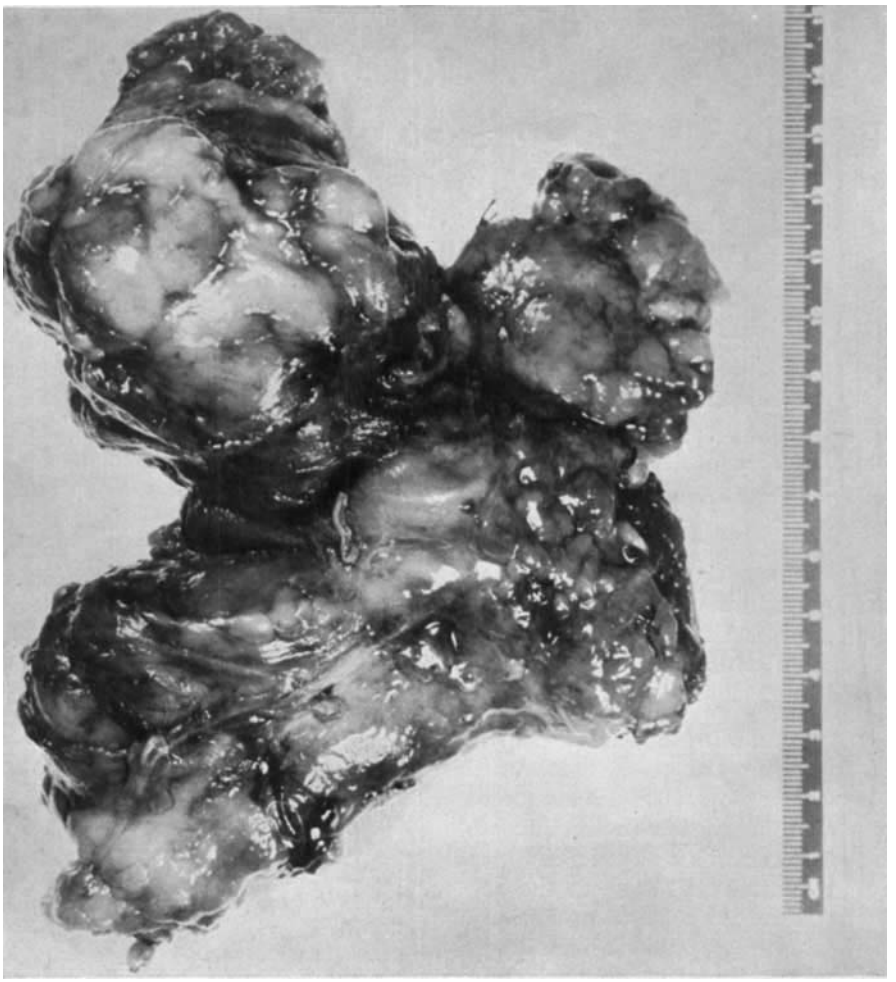


FIG. 17. Surgical specimen of the combined operation.

extensive, are got out of bed the morning after operation.

Wound Care and Dressings. In the operating room a bulky pressure dressing supported by an elastic bandage is applied. A judicious amount of pressure over the skin flaps not only improves the circulatory recovery of the tissues but reduces the amount of seepage of serum into the wound. Drainage will be fairly copious for the first few days. The dressing should be changed daily so as to redistribute and equalize the pressure. The drain is loosened and shortened daily so as to prevent pocketing of serum beneath the skin flaps. It is removed on the fourth postoperative day, at which time the tract will be so well established as to assure adequate drainage from then on.

COMPLICATIONS

Postoperative Shock. A discussion of the problem of operative shock following neck dissection is of significance mainly from the standpoint of prevention. Since the advent of liberal blood replacement, serious surgical shock is seldom encountered following neck dissection. Blood is administered at the start of the operation and continued throughout the entire procedure, even during the immediate postoperative period, and as long as the blood pressure remains significantly lower than the preoperative level. The average patient will receive about 1000 cc. of blood during the operation. The merit of such a routine is reflected in the absence of shock and in the fact that all patients are got out of bed on the morning after operation.

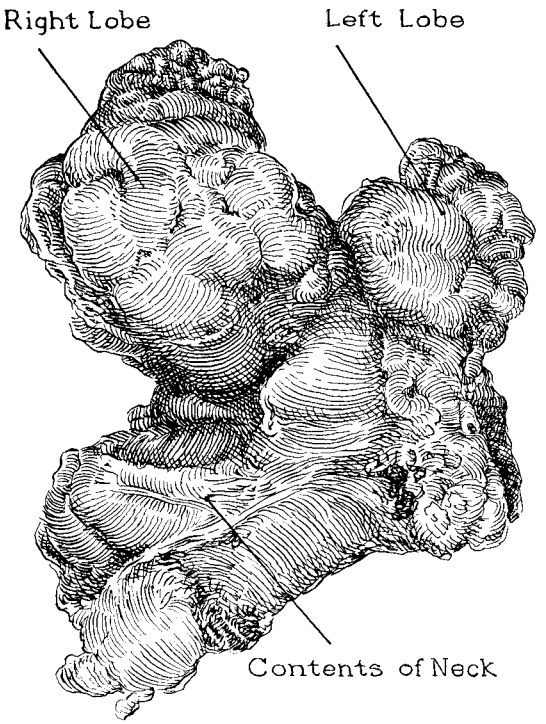


FIG. 18. Artist's drawing of the surgical specimen.

Pulmonary Complications. With the development of chemotherapy and the antibiotic drugs, improved anesthesia techniques, sodium pentothal anesthesia, the more liberal use of blood transfusions, and early ambulation, both the incidence and severity of pulmonary complications have been reduced to an almost insignificant figure. Frequent suctioning of the mouth and pharynx by the nurse removes secretions, stimulates the patient to cough, and prevents postoperative atelectasis and pulmonary infection.

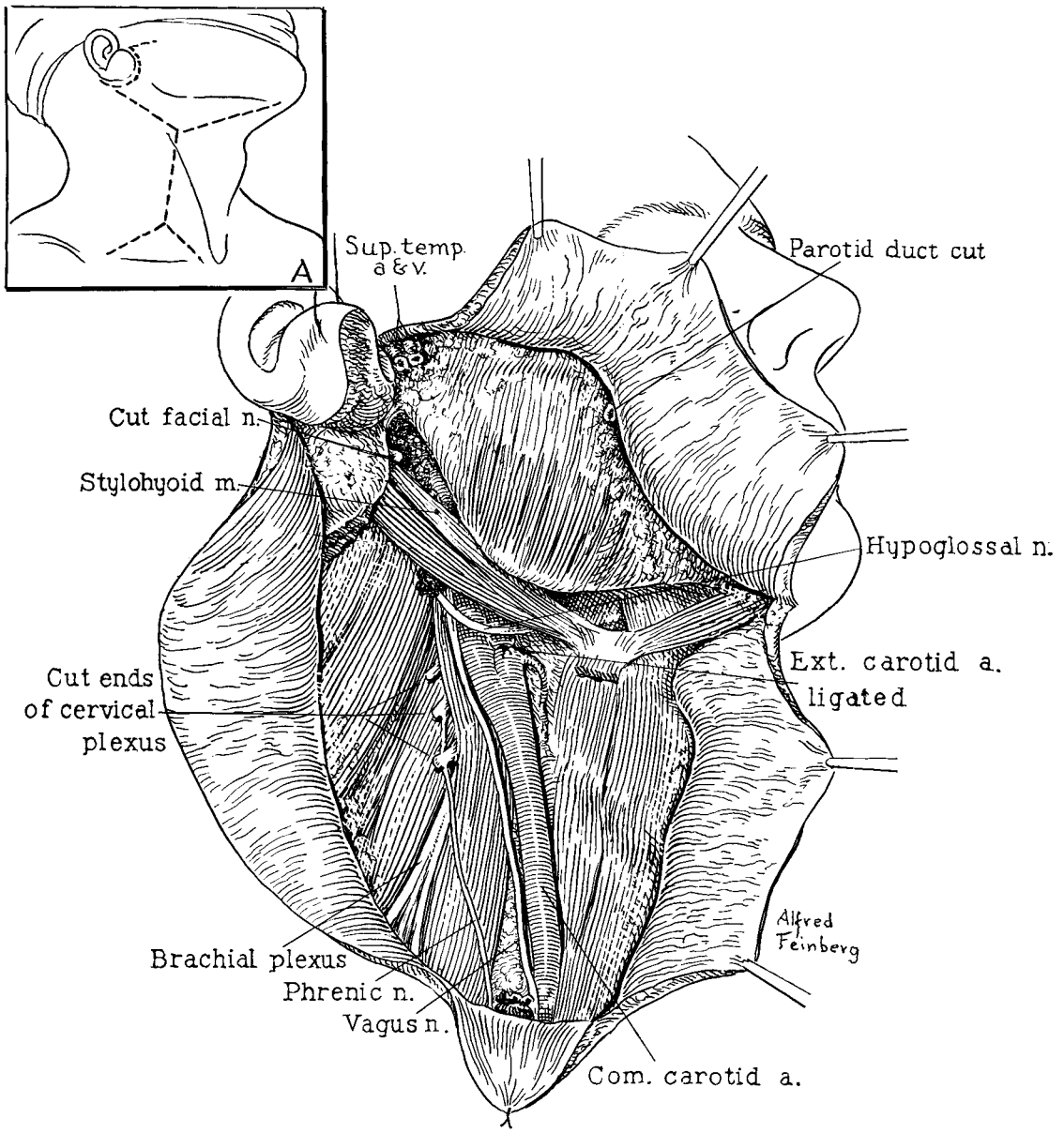
When a tracheostomy has been performed as part of the operative procedure—as is routinely done when neck dissection is combined with excision of the primary lesion in the mouth and resection of the mandible—special attention should be paid to the removal of pulmonary secretions by frequent suctioning of the tracheostomy tube with a sterile catheter. This procedure is part of a highly developed nursing regimen in our clinic.[44] In cases in which tracheostomy has been performed, oxygen may be administered postoperatively through a small enamel funnel, the wide mouth of which is placed directly over the tracheostomy tube. Oxygen is given routinely to all patients until they react fully, and its administration is continued after that time in selected cases only.

Pneumothorax and Mediastinal Emphysema. Next to ligation of the common or internal carotid artery, the development of pneumothorax during neck dissection is the most serious complication of the operation. Fortunately such a surgical accident occurs but rarely during the operation and was encountered in only three cases in the present series. Since the completion of this study, however, several additional instances of pneumothorax have complicated the postoperative course of patients following neck dissection. Most of the cases of pneumothorax that occurred during the course of the operation were not due to pleural injury but to other mechanisms which will be considered separately later.

The pleurae project into the neck (cervical pleura or cupola), extending from 2.5 to 5 cm. above the sternal end of the first rib. Despite the fact that the pleura occupies a relatively high position in the root of the neck and is contiguous to the field of operation, especially during the supraclavicular dissection, it is seldom injured. This may be attributed to the fact that the apical pleura is covered by fibromuscular tissue (Sibson's fascia) and, as already mentioned in the section on TECHNIQUE OF NECK DISSECTION, the dissection is carried out in a plane superficial to the third layer of the deep cervical fascia which overlies the scaleni muscles. Despite these protective investment tissues, the pleura may nevertheless be occasionally injured during the course of neck dissection, especially in mobilizing a thyroid cancer deeply embedded in the root of the neck or in clearing a bulky metastasis lodged behind the clavicle.

Probably the most common mechanism by which pneumothorax may develop during neck dissection is the occurrence of mediastinal emphysema—a condition that may actually be demonstrated roentgenographically. With the development of mediastinal emphysema under tension, the parietal mediastinal pleura ruptures; in this way, contralateral and bilateral pneumothorax may be accounted for.

In our clinic Bowden and Schweizer studied eighteen cases of pneumothorax and two of mediastinal emphysema that occurred during the course of operative procedures in the neck. In the majority of these patients, the etiology



Figures 19 to 21 show neck dissection combined with resection of the parotid salivary gland.

FIG. 19. The surgical specimen is removed en bloc. The facial nerve and its branches are dissected out and preserved if these structures are not involved by cancer. Note extensions of incisions in front and behind the ear permitting additional exposure.

of the pneumothorax could be attributed to the aspiration of air into the mediastinum as a result of opening the middle layer of the deep cervical fascia. These authors believe that the two cases of mediastinal emphysema without pneumothorax were probably caused by rupture of marginal alveoli with the production of pulmonary interstitial emphysema.

OBSERVATION 1. In a recent case of neck dissection in our clinic to be reported by Frazell, no chylous leakage was noted at the time of operation, and there were no immediate postoperative complicating incidents. Within four days the patient developed increasing dyspnea, and a roentgenogram of the chest revealed fluid in both pleural cavities (Fig. 27). Thoracentesis yielded a copious

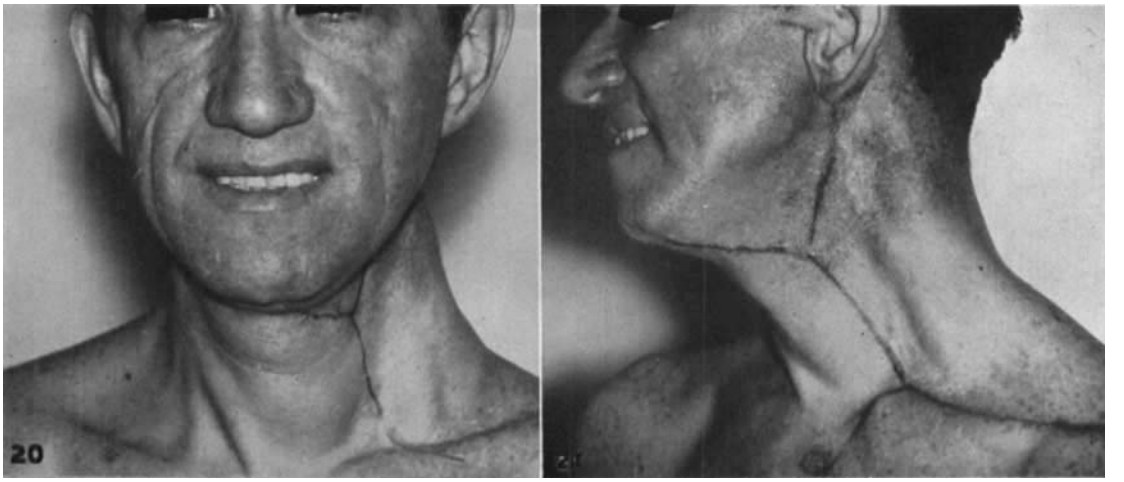


FIG. 20. Postoperative photograph of patient (frontal view). The facial nerve is preserved.

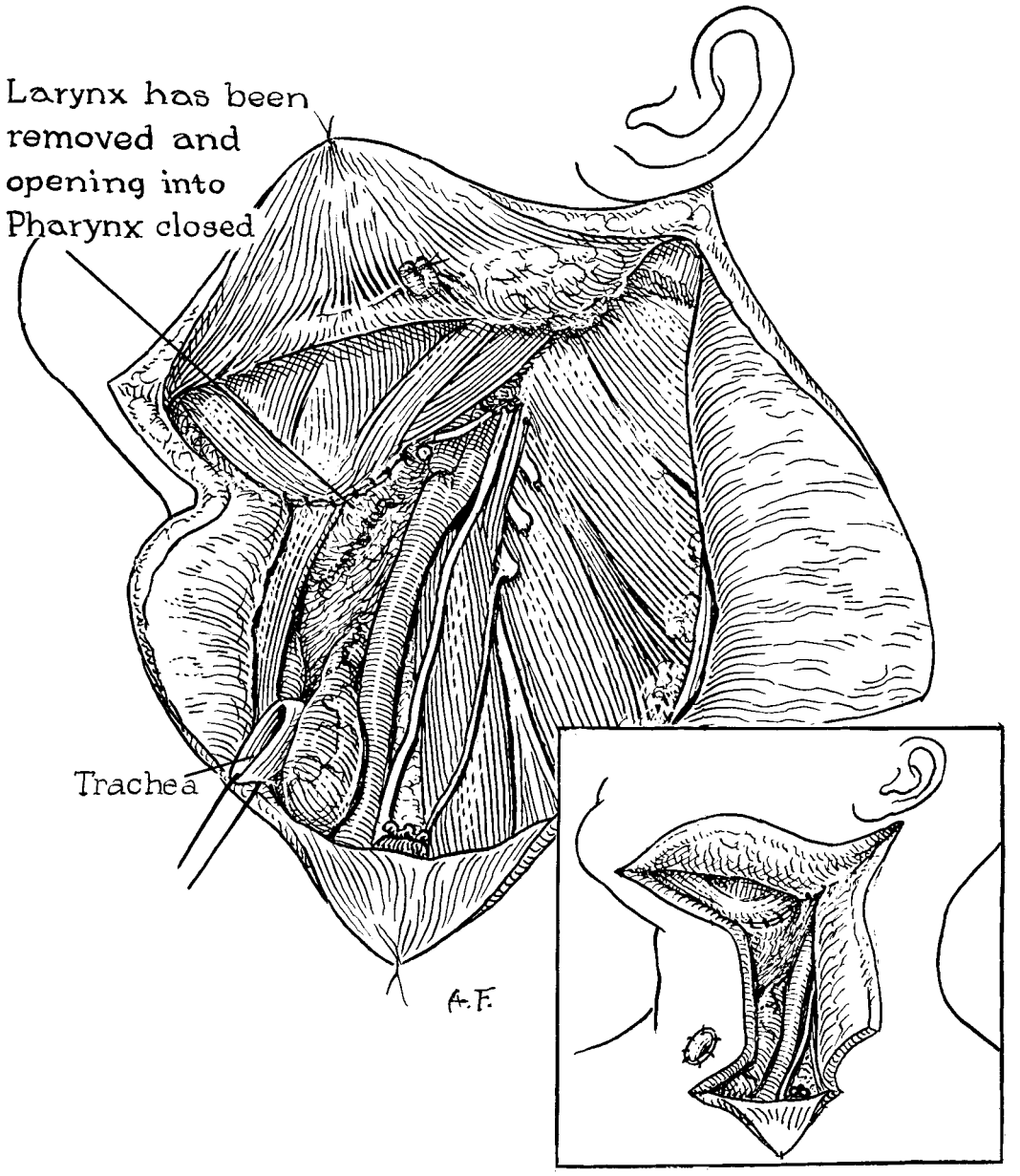
FIG. 21. Lateral view; note extension of the incision.

amount of chylous material. At about the same time, a chylous clot was removed from the neck wound, local drainage was instituted, and a total of about 2500 cc. of chyle was aspirated from the chest. The patient recovered; and as far as can be determined, this case is the only published account of recovery following bilateral chylothorax. These events support the theory just presented: that air is forced into the superior mediastinum by an opening in the deep cervical fascia and that the parietal pleura is secondarily ruptured by the dissection of the air in the mediastinum.

The possibility of pneumothorax must be kept in mind especially when operations for extensive thyroid cancer are performed. It is best to recognize this complication in the operating room rather than have the diagnosis delayed until the patient has been returned to the ward, for by this time considerable respiratory embarrassment may have occurred. A competent and alert anesthetist can detect such an accident long before the surgeon becomes aware that his patient's respirations are rapid and labored.

The administration, by the anesthetist, of oxygen under positive pressure is a simple matter, since all patients are intubated prior to operation. Positive pressure, however, is contraindicated in the presence of tension pneumothorax and is useful only when there is an open wound in the pleura. The initial supportive treatment by the anesthetist enables the surgeon to continue with the operation and to discover and repair a pleural rent if one is present. When the operation has been completed and the dressing applied, a roentgenogram of the chest is taken BEFORE any procedure is done for the relief of the pneumothorax to make absolutely certain of the diagnosis; to establish whether the pneumothorax is unilateral, bilateral, or even contralateral; and to determine if mediastinal emphysema is also present. It is advisable to await roentgenographic diagnosis only when the condition of the patient is good enough to warrant delay of a chest tap. If the patient's condition is poor, it is justifiable to proceed with therapy (thoracentesis) without roentgenographic confirmation of the diagnosis.

After the status has been definitely established by roentgen-ray studies, the involved pleural cavity is aspirated and underwater drainage is established on the affected side. If the pneumothorax is bilateral, the same rationale of procedure is followed, except that both pleural cavities are aspirated. It is obvious that, throughout the entire period of this serious complication, the patient must receive oxygen in addition to supportive cardiac therapy. Since there has been respiratory embarrassment and since the patient cannot be got out of bed early, every effort must be made to prevent atelectasis and subsequent pneumonitis. If there is any clinical or roentgenographic evidence of retained pulmonary secretions, frequent tracheal aspiration with a catheter is the most effective method of



Figures 22 to 25 show neck dissection combined with total laryngectomy.

FIG. 22. Neck dissection and excision of the larynx and adjacent strap muscles may be performed in one stage and the entire surgical specimen removed en bloc. Opening into the pharynx with contamination of the tissues of the operative field during the procedure does not interfere with subsequent wound healing (use of penicillin, etc.).

clearing the respiratory tract and stimulating the patient to cough vigorously.

Air-Sucking Wounds of the Neck. An occasional observation during the course of neck dissection, tracheostomy, or other surgical procedures in the supraclavicular regions or in Burns's suprasternal space is a sucking in of air by the loose areolar tissues in the area. This phenomenon may so closely simulate the picture produced by the sucking in of air in the root of the neck following a traumatic rent in the apical pleura that the surgeon may often find it difficult to decide which mechanism is responsible. In the former, the sucking in of air—due to retraction of the upper in-

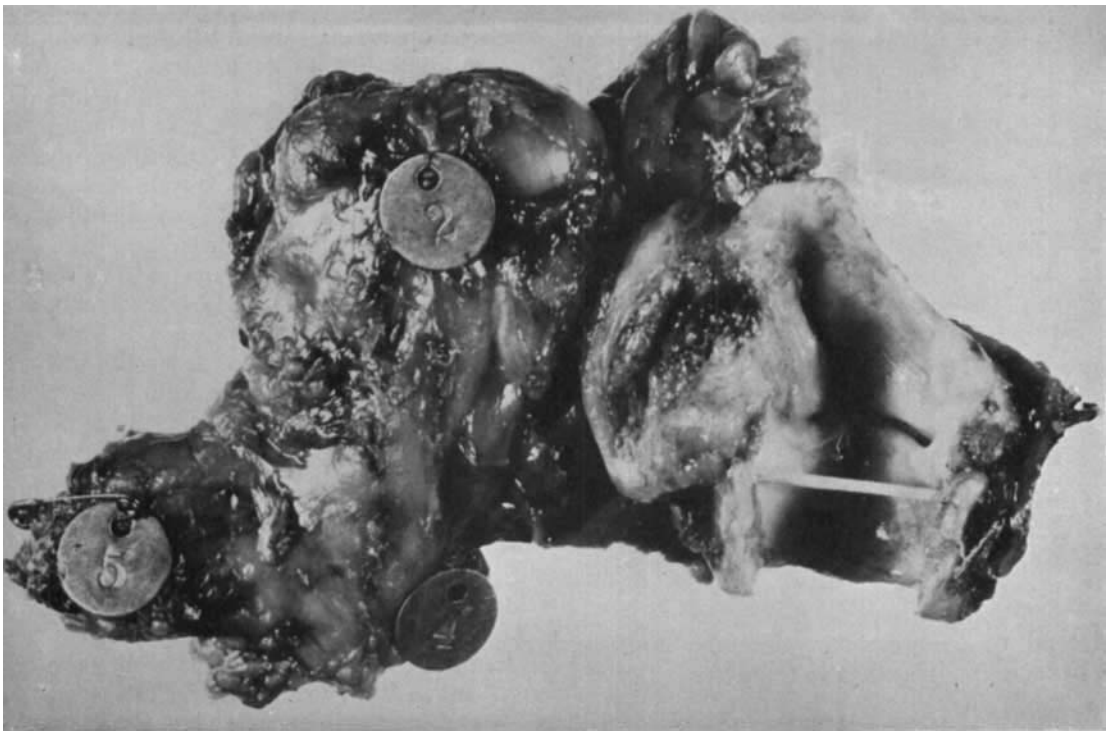


FIG. 23. Surgical specimen following combined neck dissection and total laryngectomy.

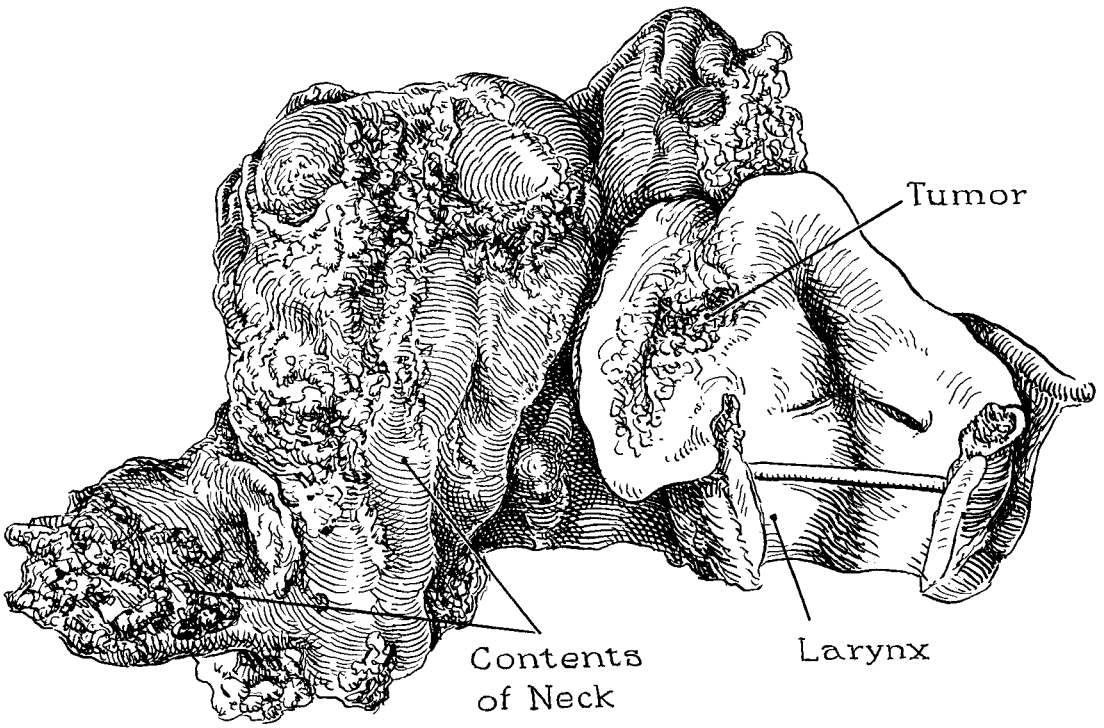


FIG. 24. Artist's sketch of the surgical specimen.

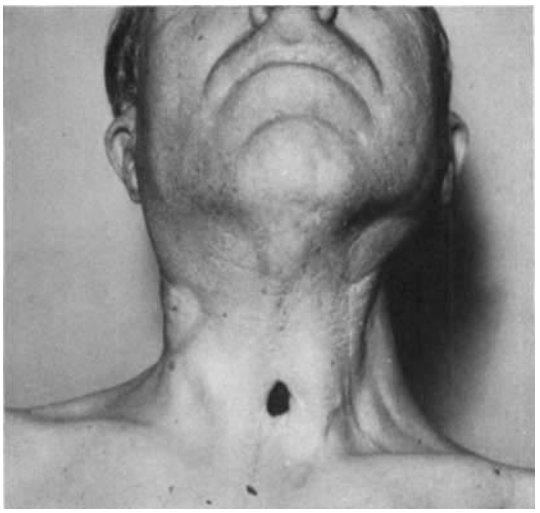


FIG. 25. Photograph of a patient seven months after combined neck dissection and total laryngectomy.

tercostal muscles and the accessory muscles of respiration—produces no actual "blowing" effect; whereas, when a traumatic pneumothorax has been produced an audible air current may be noted in the locality where the accident has occurred. If the surgeon cannot decide whether the sucking in of air at the root of the neck is due to injury of the apical pleura or to muscle retraction at the root of the neck, the anesthetist may be alerted, and in a short time the actual cause of the disturbance may be determined by observing the bag of the anesthesia machine closely.

Thoracic-Duct Injury. From the practical standpoint, it is not always possible to avoid injury to the thoracic duct by the basically sound surgical principle of first identifying an important structure for the purpose of preserving it. The thoracic duct and its tributaries are embedded in a mass of loose arcolar fatty tissue, and these lymph vessels are nearly the same color and texture as the fat in which they lie. Usually the surgical patient has fasted for several hours prior to the operation, and the lymph (chyle) circulating in the thoracic duct may be only slightly turbid. Even by the most painstaking dissection it is sometimes impossible to identify the thoracic duct or its tributaries before the leakage of chylous fluid is noted.

When, by such chylous leakage, it is evident that the thoracic duct or one of its tributaries has been opened, a careful attempt at closure should be made. This maneuver requires a meticulous technique, for rough manipulations may only increase the tear. Nonabsorbable material, such as silk, cotton, or nylon, should be used for ligatures. In most cases the leakage may be stopped by ligation, although in some cases further chylous drainage will appear on the first or second postoperative day. There need be no fear of any untoward complications following complete ligation of the thoracic duct in the neck, for there are numerous collaterals (including the right lymphatic duct) that take over the function of the main thoracic duct should the latter be occluded.[40]

When chylous drainage occurs during the postoperative period, it is usually best to pursue a waiting policy for a few days, making certain that drainage is adequate. If there is copious drainage, the chyle may tend to collect under the skin flaps, to infiltrate the tissues, and to form a rather firm clot.

OBSERVATION 2. In September, 1948, a patient was admitted to the Memorial Hospital with a chylous cyst of three-months' duration following biopsy of a thyroid cancer at another clinic. Despite this, neck dissection, hemithyroidectomy, and excision of the chylous cyst were performed without difficulty.

An accumulation of clotted chyle, especially the chylous infiltration of the tissues, delays healing and may produce local wound suppuration. In such cases the skin flaps should be laid back widely, the chylous clot removed, and an attempt made to ligate the leaking point. The identification of the transected thoracic duct is usually difficult and often impossible. In some cases, a small pledget of oxycellulose applied to the leaking point and held in place with a gauze tampon may suffice. Even though no corrective measure may be successful in stopping the leakage, the outcome is usually satisfactory so far as life is concerned. The drainage will invariably stop in a period up to about six weeks. From then on the only complications are those associated with delayed wound healing.

Shoulder Pain and Disability Associated with Section of the 11th Cranial and Cervical Sensory Nerves. As has been previously stated, the spinal accessory nerve should be sacrificed routinely in all cases of neck dissec-

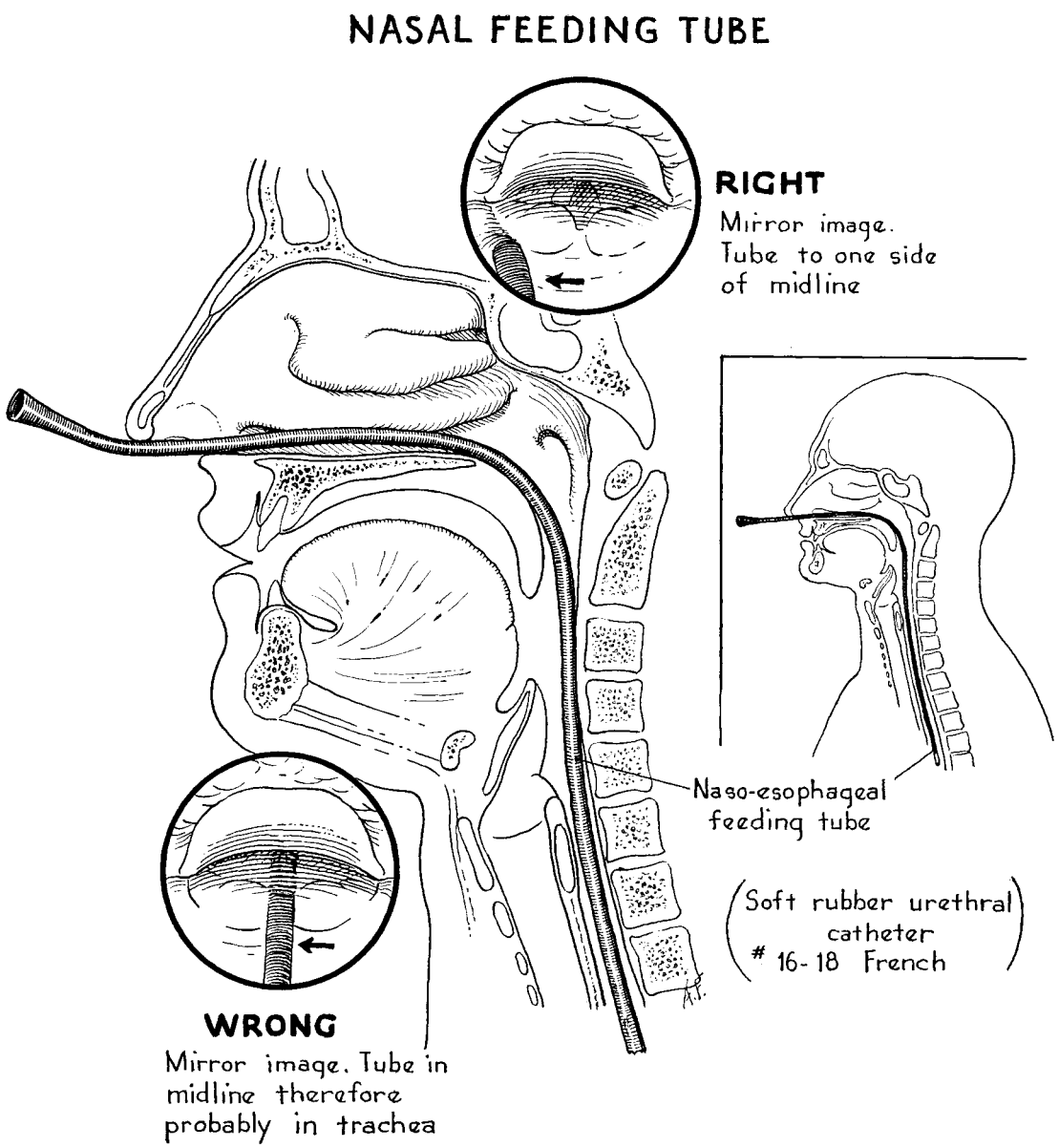


FIG. 26. Insertion of the feeding tube. The nasoesophageal catheter is passed through the nasal cavity and pharynx into the esophagus. The position of the tube should be checked with a laryngeal mirror, if possible, to make sure that the catheter is in the esophagus and not in the trachea. When, for some reason, mirror examination of the hypopharynx is difficult or not feasible, direct inspection of the oropharynx through the open mouth will show the tube in the mid-line of the posterior pharyngeal wall if the catheter is in the trachea; the tube will be seen to lie to one side of the mid-line if it is in the esophagus.

tion. Otherwise, the complete removal of the lymphatics in the subdigastric area and in the posterior cervical triangle cannot be effectively accomplished. Following traumatic paralysis of the spinal accessory nerve, a specific disability occurs that is confined to the shoulder on the affected side (bilaterally in bilateral neck dissection).

The characteristic disability following such paralysis is a "shoulder drop." The degree of the deformity is so moderate, however, as to cause little complaint on the part of the

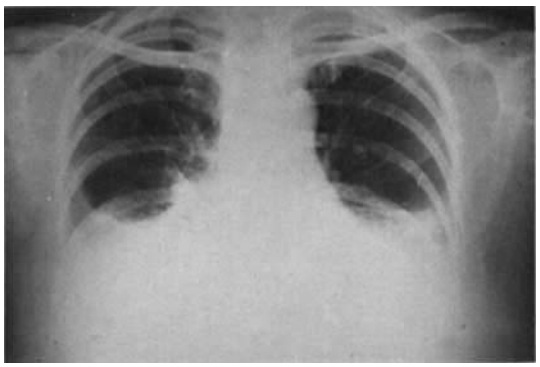


FIG. 27. Complications following neck dissection: bilateral chylothorax. Roentgenogram showing fluid in both pleural cavities. Thoracentesis yielded large amounts of chyle. This phenomenon is additional evidence that mediastinal emphysema may occur during neck dissection; the air may rupture through the mediastinal pleura and produce pneumothorax (homolateral, contralateral, or bilateral)—a relatively serious postoperative complication.

patient. Certain movements and motions of the arm and shoulder are somewhat interfered with, that is, in raising the arm above the head, or in performing such actions as putting on a coat. In cases of bilateral neck dissection with sacrifice of both spinal accessory nerves, the patients are usually fairly comfortable and complain only slightly of the aforementioned disability.

OBSERVATION 3. We have recently observed one of our patients who had bilateral neck dissections in two stages about two years ago. When inquiry was made as to the extent of disability incident to the bilateral surgical procedure, it was learned that the patient had continued to play golf after the operation. He stated that he had played a rather consistent game of between 80 and 85 prior to the operation; subsequently, his score continued at about the same level, but since the operation a previously troublesome "slice" had disappeared.

During the dissection, the cervical nerves (2d, 3d, 4th) are cut just at their emergence in the groove between the splenius capitis and trapezius. As a result a certain number of patients will complain postoperatively of pain referred to the side of the neck and shoulder probably as a result of nerve-stump trauma. Rarely, amputation neuromas have developed in these stumps, producing trigger-like pain and requiring excision of the neuromas and injection of alcohol into the nerve stumps. All of the patients have been relieved by this procedure.

Vagus Nerve. As previously mentioned under the section on VARIATIONS IN PROCEDURE OF NECK DISSECTION, certain vital nerves may be deliberately included in the dissection if sacrifice of those structures is necessary to remove the disease completely. The vagus nerve was deliberately transected in nine cases of the present series. A mortality rate of 60 per cent in this group would appear to indicate, superficially at least, that the complication from section of the 10th cranial nerve is a serious one. As a matter of fact, the common carotid artery was ligated in four of these cases, thus accounting mainly for the high mortality rate. The vagus nerve together with the common carotid artery and internal jugular vein is enveloped in an extension of the deep cervical fascia, referred to as the carotid sheath. These three structures are in such close proximity to each other that if cancer involves the vagus nerve, the common carotid artery, also, will be frequently invaded by disease. Rasmussen,[53] in reviewing a series of thirty cases on the Head and Neck Service at Memorial Hospital in which the vagus nerve was sacrificed either during neck dissection or some other surgical procedure in the neck, found that five patients (17 per cent) did not survive the operation; of these, the common carotid artery was ligated or resected in four of the cases, and one patient died of diffuse bilateral pneumonitis. This clinical analysis corroborates our observations that the frequent association of common (or internal) carotid-artery section with sacrifice of the vagus nerve is the main reason for the appreciable mortality rate in these cases.

Other significant complications that may be anticipated after section of the vagus nerve in the neck are hoarseness (recurrent laryngeal paralysis), tracheal aspiration and secondary pneumonitis (superior laryngeal nerve paralysis), and transitory dysphagia (motor branches to pharyngeal constrictors). If the vagus nerve must be sacrificed during neck dissection in order to encompass and remove the disease, this variation of the procedure per se should not complicate the postoperative course of the patient too significantly, provided the common and internal carotid arteries are preserved.

(The question of bilateral vagus section is hardly likely to arise in neck dissection. We have observed cases in which both vagus nerves were so involved by fibrosis following otherwise successful radiation therapy of bilateral cervical metastases that bilateral laryngeal paralysis gradually developed several years following treatment. Such a complication could only be explained by permanent interruption of both vagus nerves. The complication is a serious one for the reason that the glottis will not close during the act of swallowing and the ingesta enter the trachea. This difficulty may be partly eliminated by feeding via a nasoesophageal catheter, but nevertheless the oral secretions tend to spill into the trachea followed by progressive pulmonary suppuration and finally death unless total laryngectomy is performed.)

Edema and Congestive Cyanosis of the Face. As already mentioned under the section TECHNIQUE OF NECK DISSECTION, the internal jugular vein is excised from the level of the clavicle to the angle of the mandible. In unilateral neck dissection, the removal of all the main venous channels is followed by no clinical evidence of impaired venous return from the tissues of the head and neck. In bilateral neck dissection, however, definite manifestations of at least transient impairment of the venous return do appear in the form of dusky cyanosis and diffuse swelling in the skin of the face and occasionally lymphedema. If one is not familiar with the immediate appearance (sometimes striking) of patients following bilateral neck dissection, the examiner will become concerned, since he might attribute such cyanosis to an inadequate airway or to some pulmonary or cardiac complication. In about half of the cases, the second stage of a bilateral neck dissection is not followed by any signs of venous engorgement of the face.

Congestive cyanosis and edema of the face following bilateral neck dissection, if it occurs at all, will be noted at the conclusion of the operation and will increase during the next twelve to twenty-four hours, after which these symptoms gradually subside, normality being reached in a period of about one to two weeks. In this regard, it is interesting to note that despite the fact that the major venous channels draining the blood from the brain have been eliminated (jugular system of veins), there is, nevertheless, no indication that such patients develop increased intracranial pressure (due to chronic passive congestion of the brain) even in a transitory way. Recently Sugarbaker reported his observations in five cases of bilateral neck dissection (excision of both internal jugular veins in two stages), but in our opinion, it is doubtful whether the mortality (two cases) in this series was in any way related to increased intracranial pressure. On the Head and Neck Service of the Memorial Hospital, examination of many patients following bilateral neck dissection has not revealed a single instance in which there was papilledema or a serious rise in the blood or spinal fluid pressures. Increased intracranial pressure as a complication of bilateral neck dissection will be discussed in greater detail in the section *Complications Following Bilateral Neck Dissection.*

Air Embolism. When veins such as the internal jugular, subclavian, or their larger branches are opened inadvertently (rather than sectioned between clamps or ligatures), there is sufficient negative pressure in the proximal segment so that air is often sucked into the lumen of the vessel. Much has been written in the past regarding the serious sequelae incident to such air embolism. During the course of neck dissection, tears may be made in the internal jugular or the larger thyroid veins and, before the opening can be closed by clamping, air will be heard to enter the veins. In our clinic, although such a phenomenon has occurred many times, we have never observed any apparent complications to follow such an incident.

Failure of Ligature of the Upper or Distal Stump of the Internal Jugular Vein. If the clamp holding the stump of the upper end of the internal jugular vein should slip, it is ordinarily not difficult to replace the clamp although bleeding is brisk. In other cases when an effort has been made to ligate the internal jugular vein unusually high under the posterior belly of the digastric muscle because of invasion by metastatic nodes at this point, the stump of the vein may slip from the clamp owing to a combination of circumstances such as a fragile vein wall, a faulty clamp, or a faulty application of the clamp. In such instances it may be impossible to grasp the short venous stump by clamping and placing a ligature about it. This has occurred two or three times in our experience. The surgeon need have no particular concern as to the outcome in these cases. Bleeding is

first arrested by digital pressure over the jugular foramen. A tampon about 3 cm. in diameter of absorbable material, such as gelfoam or oxycellulose, over the area is held in place by a gauze packing, the end of which is brought out through the drainage opening in the lower neck. The skin flaps are sutured over the gauze tampon, and a compression dressing is applied. If left for three or four days, the gauze tampon packing can be gently removed, and the postoperative course is usually uneventful. No fatalities due to this accident have occurred in our cases.

Injury to Subclavian Vessels. During the average neck dissection, the operative field at the root of the neck does not extend below the level of the clavicle. In an occasional case, however, especially when the surgical procedure is being performed for thyroid cancer or a metastatic mass which is lodged behind the clavicle, the dissection must necessarily extend to a lower level. The subclavian vein, therefore, may be injured if the disease is bulky and the anatomic landmarks have been obliterated. Such an accident occurred in three cases in the present series and was readily controlled by primary repair of the vessel or by packing with gauze.

An injury to the subclavian artery is not likely to occur since this vessel lies behind the scalenus anticus, and the dissection is carried out superficial to this muscle. In the present series the subclavian artery was injured in three cases and successfully repaired in two. In one instance, injury to this vessel accounted for one of our fatalities.

OBSERVATION No. 4. While dissecting deeply in the root of the neck on the right side, arterial hemorrhage occurred. In an effort to control this bleeding, a rent was made in an atheromatous subclavian artery. The vessel crumbled, so that primary suture of the torn artery was not attempted. The area was packed tightly, and this procedure temporarily controlled the bleeding permitting completion of the operation. About twelve hours postoperatively the bleeding recurred, and the subclavian artery was ligated after removal of the clavicle. The patient died of shock one hour later.

Paralysis of the Lower Lip. Good surgical technique requires that the mandibular branch of the facial nerve be identified while the upper skin flap is being developed. (Fig. 3.) The nerve courses downward and forward through the parotid salivary gland, across the external maxillary artery and anterior facial vein and then continues forward and upward deep to the fibers of the platysma to terminate in the muscles of the lower lip. This branch reaches the lowest point in its course as IT CROSSES THE EXTERNAL MAXILLARY VESSELS where the nerve lies at or about the level of the inferior border of the mandible. The danger of injury to the mandibular branch of the facial nerve is almost entirely in the region of the external maxillary artery and the anterior facial vein at a point where these vessels must be transected in the course of dissecting along the inferior border of the mandible. Since the prevascular and retrovascular submaxillary nodes lie just below the level of the mandible, a painstaking and clean dissection is necessary in this area. As previously mentioned, the tail of the parotid salivary gland should be routinely included in the resection; this maneuver will not be followed by paralysis of the lower lip. Such disability will occur only if the RAMUS MARGINALIS MANDIBULAE is injured at the lowermost point in its course as described earlier.

Respiratory Obstruction. This condition, which may be produced by a variety of causes, is one of the most serious complications in neck dissection and may lead to a postoperative mortality. The principal etiological factors in the production of respiratory obstruction during or following neck dissection are: (1) too early removal of the endotracheal tube following pentothal anesthesia; (2) failure to perform elective tracheostomy in selected cases; (3) obstruction of the tracheostomy tube by a bulky dressing; (4) premature removal of the tracheostomy tube; (5) postoperative wound hemorrhage.

It is the routine on the Head and Neck Service at the Memorial Hospital to perform most of the operative procedures under pentothal sodium anesthesia and endotracheal intubation. In the event that the breathing tube is withdrawn before the patient has fully reacted, laryngospasm may occur.

OBSERVATION 5. Several years ago a nurse was assigned to watch a patient who had just been returned to the ward following neck dissection. The patient showed some signs of reaction from the anesthesia, had not actually recovered fully, and was not coughing through

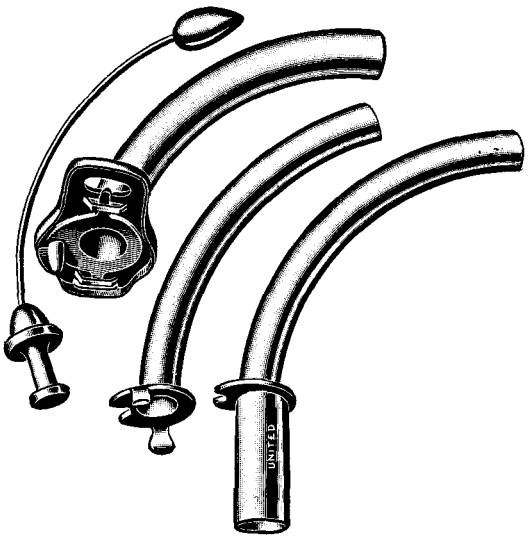


FIG. 28. Tracheostomy extension tube. Following neck dissection combined with resection of the mandible, tracheostomy is performed routinely. In these cases, the pressure dressing is necessarily bulky, and there is always a possibility that the external opening of the tracheostomy tube may become buried in the massive dressing with subsequent asphyxia, especially if an unconscious patient is left unattended even for a few minutes. The extension tube shown here is attached to the tracheostomy tube so that an airway is assured in such cases.

his tube. The airway (endotracheal tube) was removed by the nurse, and the patient became cyanotic instantly (laryngospasm). Fortunately, the house officer who had accompanied the patient to the ward from the operating room was still on the floor. Immediate tracheostomy was done at the bedside, and the patient made an uneventful recovery.

This serious complication is best treated by immediate tracheostomy, since the spasm of the cords is such that reintroduction of the breathing tube is difficult if not impossible, and no time must be lost in establishing an airway. In the event that an anesthetist is at hand, such a condition might possibly be successfully treated by the administration of intravenous curare, and, if necessary, oral intubation through the glottis by direct laryngoscopy.

In the straight radical neck dissection, respiratory obstruction does not play any significant role in postoperative mortality, providing there is no laryngeal edema as a result of previous radiation therapy or operation. In the uncomplicated case of a unilateral neck dissection, therefore, edema of the larynx does not occur as a result of the operative procedure. On the other hand, whenever the mandible is sectioned in the combined operation for mouth cancer, or any other extensive surgical procedure (resection of the pharynx, etc.) is performed in combination with neck dissection, some degree of respiratory obstruction is the rule because of supraglottic edema. The same is true after the second stage of a bilateral neck dissection. Although these patients may go through the postoperative period without tracheostomy, the danger of an impaired airway is so great that tracheostomy should be performed routinely in all cases of combined operations as already mentioned. The performance of elective tracheostomy when radical neck dissection is combined with resection of the mandible has been routine on the Head and Neck Service of Memorial Hospital for the past ten years after postoperative deaths had been narrowly averted by emergency tracheostomy. No respiratory complications of this nature have been experienced for the last several years since the policy of routine elective tracheostomy has been performed in the combined operation.

Because of the extensive skin flaps that are developed during neck dissection, the use of a bulky pressure dressing is indicated (fluffed gauze, mechanic's waste, or sea sponge, and elastic adhesive). Even though precautions are taken to make sure that the tracheostomy tube is free and clear, such patients must be watched diligently for the first twenty-four to forty-eight hours so that the external opening of the tracheostomy tube does not become buried in the dressing with consequent asphyxia. Furthermore, there is always a possibility that the outer tracheostomy tube may slip out during the postoperative period so that the strings which keep the tracheostomy tube bound snugly to the neck must be tied carefully. We have developed a modification of the standard tracheostomy tube for use with bulky dressings (Fig. 28).

Since all wounds following neck dissection are drained, postoperative hemorrhage beneath the flaps should not produce tracheal compression and obstruction to the airway.

Dysphagia. Moderate difficulty in swallowing for the first few postoperative days is a common complication following neck dissection. In most cases, dysphagia may be attributed to a combination of the moderate

trauma of the laryngoscope during the insertion of the nasotracheal breathing tube or to a disability incident to the operative trauma of the deep tissues of the neck adjacent to the hypopharyngeal wall. In other cases, there may have been trauma to the superior laryngeal nerve or its external branch causing anesthesia of the homolateral side of the lower hypopharynx. In any case, the complication is usually transitory, but the patient may be made more comfortable and his fluid balance and nutrition more satisfactorily maintained if a nasopharyngeal feeding catheter is inserted immediately following recovery from the anesthesia.

More serious impairment of swallowing may occur when neck dissection is combined with section of the mandible. In such cases there may be marked anatomical alterations in the floor of the mouth, tongue, and pharynx, so that attempts to swallow may result in aspiration of food into the trachea. In these instances, also, the difficulty disappears spontaneously. Usually the patient is able to swallow an adequate liquid or soft diet within a few days to a week.

Wound Infection. Before the advent of chemotherapy, antibiotics, blood banks, and an understanding of the relationship of nutritional deficiency to wound healing, it was not uncommon to encounter patients who, following neck dissection, had edema or necrosis of the skin flaps or actually pyogenic infection in the neck. In present-day surgical practice, however, healing per primum is almost the rule even in patients previously subjected to radiation therapy.

As previously mentioned in the section under *Thoracic-Duct Injury,* when chylous drainage complicates the postoperative course of patients following neck dissection, it is important to maintain a wide opening at the drain site and to make every attempt to prevent secondary infection. If chyle is allowed to infiltrate the skin flaps and the deeper tissues of the neck, secondary infection does occur and tissue necrosis and sinus formation may complicate the postoperative course.

Horner's Syndrome. The incidence of this syndrome, both temporary and permanent, following neck dissection is frequent. The tetrad of symptoms—ptosis, miosis, enophthalmus, and anhydrosis—commonly follows trauma or undue stimulation of the cervical sympathetic trunk that lies posterolateral to the carotid sheath. In the routine neck dissection, the operative procedure is not deliberately extended posteromesial to the carotid sheath, and the cervical sympathetic trunk, therefore, should not be traumatized. Inadvertently, however, the dissection may be carried sufficiently deep so that the sympathetic chain is injured, or in other cases the metastatic disease may be so placed that the dissection is necessarily carried to this deep level.

During the first few postoperative days, the symptom complex is mainly objective in nature, that is, it will be discovered during the course of clinical observation. In other cases it may become evident only when the patient is up and about, when he looks into a mirror and discovers an inequality in the size of the pupils. The patient with a Horner's syndrome becomes concerned mainly because of the cosmetic appearance.

A Horner's syndrome of long standing is sometimes said to lead to heterochromia (depigmentation of the iris), hypotonia of the eye, and even to cataract. Several cases of Horner's syndrome of long standing in the present series were carefully observed by our ophthalmologist, and none of these sequelae was noted.

Complications Following Bilateral Neck Dissection. It was formerly believed that excision of both internal jugular veins was not a safe procedure for the reason that there would be no adequate channel for the return of the venous blood from the brain.*[21, 23, 62] During the last fifteen years bilateral neck dissection with excision of both internal jugular veins has been carried out whenever indicated on the Head and Neck Service of the Memorial Hospital. In the series of 665 operations from which the statistics were compiled for the present study, bilateral neck dissection was performed in sixty-six patients, and in these sixty-six bilateral procedures (132 operations), there were no postoperative deaths (as compared with an over-all mortality rate of 3.4 per cent in the whole series of 665 operations). In brief, bilateral neck dissection with

* The relatively recent recognition of the safety of bilateral section of the internal jugular veins is interesting because as far back as March, 1937, in a personal communication to one of us, George W. Crile, Sr. stated that in *a single case* he had "removed a portion" of a second internal jugular vein following a unilateral neck dissection and "noted no ill effect."[20]

sacrifice of both internal jugular veins is not attended by any particular danger and in our clinic (fifty patients with histologically proved bilateral cervical metastases) has resulted in a net five-year cure in 30 per cent of the patients.

When the practicability of bilateral neck dissection was first considered, one of us (H. M.) undertook to review standard textbooks of anatomy to establish the alternate pathways of venous return from the brain. The notes soon became so voluminous as to preclude an attempt to set down all the details in a report such as the present. In brief, it may be stated that the main auxiliary channels by which the venous blood returns from the cranial cavity to the heart are as follows (not necessarily listed in the order of their importance): the vertebral veins, the posterior condyloid and occipital veins, the emissary veins, the ophthalmic veins; the pharyngeal, pterygoid, and esophageal venous plexuses. Perhaps just as important as the alternate venous channels for the return of the blood from the brain to the heart, just listed, is the significant fact that ordinarily the veins in the head and neck of man have no valves, except at the point of emptying of the internal jugular veins, thus making possible the easy retrograde flow of venous blood. Furthermore, the veins of the brain, of the meninges (the venous sinuses), and of the skull bones (the diploic veins), and the veins of the extracranial plexuses anastomose profusely. The venous sinuses are storage lakes as well as pathways of drainage, and their thin walls indicate that their contents are under low pressure.[3] All of these anatomical peculiarities of the veins of the head, viz: lack of valves and easy retrograde flow of blood, numerous collateral venous channels, and the large cranial venous sinuses, explain in a large measure why venous congestion of the brain sufficient to produce increased intracranial pressure does not characteristically occur following excision of both internal jugular veins.

One recent report by Sugarbaker emphasizes the possible danger following excision of both internal jugular veins, namely, increased intracranial pressure. Sugarbaker states that such rises have occurred in some of his cases, and he believes that this phenomenon may be responsible for serious sequelae and even mortality. It seems to us that this author lays too much stress on the occlusion of the jugular venous system as a cause of increased intracranial pressure. Although Sugarbaker mentions that a rise in the subarachnoid spinal pressure occurs with positioning of the head, he apparently does not think this a significant factor. He fails to recognize THE TRANSITORY NATURE OF THE INCREASED PRESSURE, since it returns to normal within a few minutes, even though the jugular occlusion is permanent. Thus, considerable doubt arises as to whether obliteration of the internal jugular veins is actually a cause of increased intracranial pressure or whether this occasional transient finding (manometric only) may not rather be due to the stimulation of the cervical sympathetic nerves, since the rises may also be obtained during a one-sided neck dissection.

The references in the literature regarding fatalities after bilateral internal jugular occlusion are not based on well-documented cases.[4, 12, 22, 25, 37] Other observers are of the opinion that bilateral occlusion of the jugular venous system in two stages is perfectly safe,[24, 31] and Batson feels that such a procedure is not hazardous even in one stage.

This aspect of the neck-dissection problem is now being investigated by Olga Schweizer, anesthetist at the Memorial Hospital. Observations on spinal-fluid pressures were made in patients undergoing the second stage of bilateral neck dissection, and it was found that there was an appreciable rise in the spinal-fluid pressure in these cases as recorded by the water manometer. The studies were then extended to patients undergoing the first stage or one-sided neck dissection, and a similar rise in spinal-fluid pressure was noted in these cases. Further observations were made before induction of the patient with sodium pentothal anesthesia during the period of draping and skin preparation. In several of these cases it was found that the intraspinal pressure reading with the patient asleep and his head and neck in a normal position would rise considerably before any incision was made, merely by rotating the head to one side so as to place the neck in position for the operative procedure; the pressure returned to normal as soon as the head was restored to its normal position. These studies, not as yet complete, indicate that the spinal-fluid–pressure changes that occur are most likely due to positioning of the head and neck and possibly stretching the sympathetics and other nerves, rather than to any anatomical alteration produced

by the operative procedure itself, as stated by Sugarbaker.

OBSERVATION 6. More recently, bilateral neck dissection (resection of both internal jugular veins) in combination with resection of the anterior floor of the mouth, a portion of the mandible, and the anterior one half of the tongue was performed in one stage at the Memorial Hospital. There was a marked variation in the spinal-fluid pressure readings during the various phases of the operation. The highest rise to about 800 mm. of water occurred from simple turning of the neck. The operation was satisfactorily concluded, and one hour later the spinal-fluid pressure had returned to about 130 mm. of water, with both internal jugular veins excised. Only a moderate amount of venous congestion and lymphedema was noted in the skin and soft parts of the face, and the patient's postoperative course was without incident. This single case report[46] suggests that should there be any particular indication for BILATERAL NECK DISSECTION IN ONE STAGE, then the procedure should be carried out. In this case the growth from the floor of the mouth had infiltrated into the tissues of the submental region, and there were bilateral submaxillary metastases as well as involvement of the internal jugular veins. In the preoperative discussion of the management of this patient, it was decided that it would not be practicable to attempt the removal of the primary lesion and the metastasis on one side for the reason that there would be no boundary line by which an incision could be made anywhere near the mid-line except by cutting through the disease. The same general reasons might be found in cancer of the larynx with bilateral metastases, namely, that the chances of complete removal of the disease would require opening both sides of the neck and, therefore, that the bilateral operation in conjunction with total laryngectomy might well be done in one stage.

In the average case, however, the question might be raised: why do a bilateral neck dissection in one stage when it would be more convenient and undoubtedly safer from the standpoint of operative shock to separate the operations by three intervening weeks of rest and recovery?

Before performing the second stage of a bilateral neck dissection, it is prudent to establish just before the operation whether or not there is any edema of the larynx, which, even if present in slight degree, makes it advisable to insert a tracheostomy tube at the completion of the operation. The tube should remain in place until it has been clearly established that laryngeal edema has completely subsided. In clinics in which the established routine makes preoperative and postoperative examination of the larynx difficult or where the personnel and facilities for bedside tracheostomy are not adequate, it might be best to insert a tracheostomy tube routinely at the end of the second (contralateral) neck dissection.

POSTOPERATIVE RADIATION THERAPY

Surgeons who advocate postoperative radiation therapy following neck dissection[11, 19, 33, 49, 51] seldom, if ever, include any details of the dosage factors in their reports. Those who employ or advise postoperative radiation therapy usually recommend that the entire field of neck dissection be irradiated; this would, of course, necessitate portals of at least 10×12 cm. or even more. To those whose experience in radiation therapy goes back to the early 1920's, the idea that postoperative or preoperative (prophylactic) radiation therapy in small or moderate dosage may actually affect the clinical course of cancer strikes a nostalgic note. Thirty years ago considerable confidence was placed on such "prophylactic" radiation preceding or following such operations as radical mastectomy, neck dissection, and amputation of the extremities for sarcoma. It was rather widely believed that, since large doses of radiation completely eradicated certain malignant tumors, smaller doses (in the neighborhood of a skin erythema dose) would always produce some beneficial result. As an example of the prevailing opinion of that date, Dorland's Medical Dictionary (15th edition, 1929) defines *carcinoma dose* as: *A dose of roentgen rays sufficient to cure carcinoma. Said to be 90 to 100 per cent of the erythema skin dose.* If such were true, then obviously the administration of a skin erythema dose—or, to be safe, just a little more —postoperatively to the field of operation in neck dissection would greatly contribute to the complete eradication of metastatic cancer. Certainly, no one today believes that the just-stated definition of a carcinoma dose has any basis in fact.

In our clinic, however, a significant number of cases of permanent cures of cervical metastasis by radiation therapy have been accumulated,[43] so that within reasonable limits the cancer-lethal dose under various physical set-

ups is fairly well known. Those who have produced such permanent controls of cancer by radiation therapy will readily admit that it is unsafe and impractical to give such cancer-lethal doses to the entire side of the neck following neck dissection. Since there can be no proof that the smaller doses exercise any appreciable restraining effect on residual cancer in the operative field, many surgeons no longer practice or advise a program of postoperative radiation therapy to the entire operative field following any of the radical operations for cancer (neck, thyroid, breast, extremities, etc.). Clinicians who still recommend postoperative radiation therapy to the entire operative field believe (erroneously) that the moderate dosage (about one skin erythema) exercises a "restraining effect" or that it produces a "lymphatic block" so that any metastatic emboli still present cannot progress further—arguments that are not impressive to practical-minded therapists.

On the other hand, curative radiation therapy for local recurrences is occasionally successful for postoperative recurrences. During the follow-up period a localized recurrence may be discovered in the operative field before it has reached the size of 1 to 2 cm. in diameter. In these cases heavy radiation therapy localized to the palpable mass is often successful in producing a permanent cure. In the present series of 599 cases, there are four cases of five-year cures following radiation therapy for proved recurrences.

In other instances during neck dissection the surgeon may be unable or may elect not to remove all of a metastatic mass that has invaded the common or internal carotid artery. In such cases the overlying skin may be marked so that following healing of the flaps, localized postoperative radiation therapy in curative doses may be outlined as follows: The size of the portal should be large enough to cover the palpable recurrence by a margin of 5 mm. and possibly a little more. The daily and total dosage varies to some extent according to the size of the field. The dosage of radium implantation (radon seeds) also varies with the size of the mass being treated. The technique and dosage (median figures) in a series of twenty-nine successful cases in which the presence of metastatic cancer in lymph nodes or postoperative recurrences were found in the neck (aspiration biopsy, no operative specimen) and in which, following radiation therapy alone, the patient survived without evidence of disease for five years or more is outlined as follows:

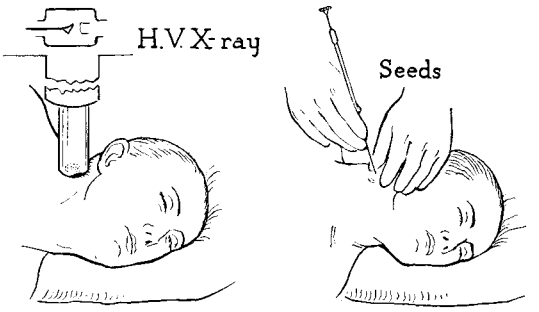


FIG. 29. Technique of radiation therapy. Following neck dissection, local recurrence or residual disease may often be successfully controlled by definitive radiation therapy (combination of roentgen-ray radiation and implantation of gold radon seeds). The surgeon tattoos the skin over the central portion of the tumor so that cancer-lethal doses of radiation may be delivered through small circular portals (3 to 4 cm. in diameter).

Roentgen-ray radiation is given in divided doses over a period of twenty to thirty days, individual treatments being given about three times a week. The size of portal should be large enough to cover the palpable recurrence by a margin of at least 5 mm. or possibly a little more. The daily and the total dosage varies to some extent according to the size of field. In our clinic the size and the shape of the beam is obtained by the use of a cylinder centered directly over the node as shown in Fig. 29. During the course of fractionated roentgen-ray radiation, supplementary gold (radon) seeds are implanted into the node.

The median size of the node in the successful cases (five-year cures) has been about 3 cm. in diameter, ranging in size from 1 to 9 cm. The median individual doses of roentgen rays is about 500 r, given three times a week. The median total dosage varies with the voltage. With 200 kv., 0.5 mm. Cu filter, 50 cm. T.S.D., the median dose is 4000 r over a period of about one month, with a range of 2700 to 6400 r. With 250 kv. the median dose in successful cases has been 5000 r, with a range of 3000 to 8000 r. With both voltages, the median dose of supplementary gold seeds in the successful cases has been 20 mc., with a range of 7 to 38 mc.

In using the dosage data given here, the median dosages in roentgens should be used with the median-size portals. The smaller

ranges should be employed with the larger portals, and the larger totals in roentgens with the smaller portals. The reverse is true with radon-seed–dosage figures; the median dosage should be used with median portals; but the smaller seed dosage should be used with the smaller portals and smaller nodes, the larger dosage with the larger portals and larger nodes.

Such radiation therapy should be employed in all cases of postoperative recurrence following neck dissection. There is no justification for a hopeless prognosis and a do-nothing attitude, for a definite percentage of these patients may still be salvaged and their disease permanently controlled. The statement is frequently made by surgeons that they referred their patient to the radiologist for "palliative radiation therapy" with the implication that there is no indication for a curative attempt, since the situation is considered hopeless. One cannot help but suspect that the surgeon is making a diplomatic gesture to his radiologist colleague rather than any real expression of confidence in radiation therapy.

Postoperative Recurrences

In present-day usage, the term "recurrence" is employed in a broad sense to designate the appearance of cancer anywhere in the body following its treatment and supposed control. As a matter of fact, the disease can reappear in several ways, in each of which the significance is entirely different. As applied to neck dissection, cancer can recur in the following ways: (1) within the operative field of the neck dissection; (2) in the same side of the neck, but outside the operative field; (3) in the lymph nodes of the opposite side of the neck; (4) in or near the site of the supposedly controlled primary lesion; (5) systemically or below the level of the clavicle. The problem of recurrences after neck dissection cannot be properly evaluated without analysis of the data according to this clinical classification.

Recurrences within the Operative Field. In the present series of 665 neck dissections, the relative frequency with which recurrences appeared in the several already mentioned sites are shown in Table 3. According to our observations the most common site of recurrence is in the operative field, especially when the surgical procedure has been a partial rather than a complete neck dissection—a strong argument in favor of the radical rather than the limited type of operation.

When the disease recurs within the operative field, it is most often found along the course of the carotid vessels, that is, along the internal jugular chain of lymphatics, possibly as a result of a tumor embolus in a lymphatic vessel left behind at the time of operation. Such recurrences are commonly found to be situated upon and often invading the wall of the common carotid artery.

In an effort to reduce the incidence of local recurrences at the operative site, some surgeons have advised the thinnest possible skin flaps so as to permit removal of the platysma muscle; in other cases, excision of areas of uninvolved skin is practiced.[12, 35] In our opinion, it is doubtful that these local recurrences lie in the superficial lymphatics and that their incidence can be significantly reduced by removal of the platysma. It appears more likely that the recurrences are situated in the remains of the network of the deep cervical lymphatics, and that when this general network contains multiple tumor emboli the chances of their complete removal are remote.

The lymphatic spread of cancer is, at first, an orderly process proceeding from the pri-

Table 3

END RESULTS AND INCIDENCE OF RECURRENCES IN 599 PATIENTS WITH 665 NECK DISSECTIONS*

Site of recurrence	Total patients No.	Total patients %	Five-year end results: Free of ca. at 5 yrs.	Five-year end results: Indeterminates	Five-year end results: 5-yr. cure rate
In operative field	203	33.9	19†	5	9.6
In same side of neck, out of the operative field	139	23.2	10	4	7.4
In the opp. side of neck	120	20.0	21	5	18.3
In primary site	141	23.5	29	5	21.3
Remote metast. outside the neck	108	18.0	2	1	1.9
Widespread recur.	8	1.3	3	—	37.5
Positive for recur., site unknown	8	1.3	—	—	0.0
Residual disease only, no recur.	14	2.3	4	1	30.8
Total patients with recur.	392	65.5	59	14	15.6
Total patients with no recur.	181	30.2	134	42	96.4‡
Total postoper. deaths	23	3.8	—	—	0.0
Total patients unknown as to recur.	3	0.5	—	—	0.0
Total Patients	599	100.0	193	56	35.5

* In cases of bilateral neck dissections, end results and incidence of recurrences are based on date of first operation.

† Four cases treated by radiation therapy and/or radon seeds.

‡ Five patients died of late effects of treatment with no evidence of cancer.

mary lesion to a regional lymph node or group of nodes. After remaining reasonably well localized to these structures for a time, the spread eventually breaks through the first line of defense and then proceeds in a more rapid, more variable, less orderly manner, and even in a retrograde fashion.

Recurrences in the operative field may also be due to those metastatic masses that, in the judgment of the surgeon, cannot be completely removed without serious sequelae and even immediate mortality. As has already been mentioned in the present study, the most common cause of such inoperability is invasion by cancer of the common or internal carotid artery. While it is technically possible to remove the mass completely together with the artery, an operative mortality of about 50 per cent will be considered by most surgeons too high to justify the sacrifice of these vital vessels. One alternative is to leave in situ the artery with the attached invading mass of cancer and to utilize postoperative radiation therapy as described in a previous section POSTOPERATIVE RADIATION THERAPY. In several instances where such a conservative procedure has been followed, the disease has been controlled locally and the patients have survived for a variable number of years. In other cases in our clinic in which the surgeon has elected to sacrifice the artery with its invading mass of cancer, patients have also recovered without incident and have remained well for several years. The 40 to 50 per cent mortality following excision of the artery with its undoubtedly greater chance of local cure of the disease is counterbalanced by the absence of operative mortality and the possible chance of control by radiation therapy. The question is one that will probably always remain a matter of choice by the surgeon in each particular case. When the artery is preserved with its attached mass of invading cancer, it is good practice to mark the overlying skin, which may be tattooed later. In this way, radiation therapy can be carried out in an accurate manner so far as the location of the skin portal is concerned.

Recurrences in the Homolateral Side of the Neck but Outside of the Operative Field. Even though radical neck dissection extends from the trapezius to the mid-line and from the inferior border of the mandible to the clavicle, recurrences just outside the operative field may take place (Table 3). This indicates that the surgeon should pay specific attention to such borders of the operative field as the upper end of the sternomastoid muscle which is cut close to its attachment to the mastoid tip. The tail of the parotid salivary gland should be included in the dissection in order to reduce the possibility of leaving behind the upper internal jugular nodes. Posteriorly, care should be taken that the skin flap is laid back far enough to expose and remove the spinal accessory chain of nodes completely. Below, the supraclavicular space should be thoroughly cleaned out, even at the risk of injury to the thoracic duct, the subclavian vein, or the pleura (especially in cases of thyroid cancer).

Recurrences in Lymph Nodes of the Opposite Side of the Neck. Radical neck dissection is obviously intended only as a means of control of metastasis in the cervical lymphatics on the side where the operation is done. From a strictly technical standpoint, the operation cannot be regarded as a failure if the disease appears later in the opposite side of the neck. In most cases, even in centrally placed primary lesions, cervical metastasis appears clinically first in one side of the neck. In cases of bilateral cervical metastases, involvement of the opposite side of the neck may not occur until several months or even years after the initial unilateral neck involvement. In a smaller number, bilateral involvement of the cervical nodes is found on admission. As shown in Table 3, metastasis appears on the opposite side of the neck in 20 per cent of patients having neck dissection, necessitating either a second-stage operation (bilateral neck dissection) or treatment by radiation if surgery is contraindicated.

Recurrences in the Primary Site. The growth will often recur at the primary site even though at the time of the neck dissection the primary lesion appeared to have been eradicated. As shown in Table 3, such recurrences in the primary site occurred in 24 per cent of our cases after neck dissection. In these patients the value of the operation is not lost completely for the procedure actually did remove the disease from the neck; and even though the growth reappeared in the primary site, permanent cure of the disease is often possible by surgery and/or radiation therapy to recurrences at the primary site.

HETEROTOPIC FOCI. In recent years it has become increasingly evident that so-called "recurrences" of mouth cancer in the primary site are not always due to residual local disease, but that in many cases these recurrences are actually new cancers arising in the adjacent oral mucosal tissues. That such an event occurs often should not be surprising, since neither surgery nor radiation therapy immunizes the surrounding local tissues that are subject to the same carcinogenic influences following treatment as those that produced the original malignant transformation. The same is true of cancer elsewhere in the body. For instance, following radical mastectomy for cancer of the breast, the disease may appear as a separate primary growth in the opposite breast. Heterotopic foci of cancer are occasionally encountered in the mouth, and in these cases it appears almost as if the entire oral mucosa is condemned. This phenomenon is also characteristic of some cancers of the rectum and colon.

Recurrences in the Form of Systemic or Distant Metastasis. One of the greatest hazards of cancer is that the disease tends to spread not only from the primary site to the regional lymphatics, where it is still possible to control it, but beyond these regional lymphatics to distant sites. Mouth cancer is no exception to this tendency of distant metastasis.

Regional lymphatics such as those in the neck and in the axilla are both good anatomical receptacles for metastatic tumor emboli coming from growths in the upper respiratory and upper alimentary tracts and from the breasts respectively, so that the possibility of cancer control in these areas by well-planned surgical procedures is reasonably high even though the disease has metastasized to the regional lymph nodes. Such a relatively favorable situation is not found in other parts of the body, as in the lung, esophagus, or stomach, nor are the inguinal lymphatics quite as effective a barrier or as suitable to operative removal as those in the axilla and in the neck. THE EFFICACY OF THE CERVICAL LYMPHATICS IN BLOCKING THE FURTHER SPREAD OF MOUTH, LARYNX, AND PHARYNX CANCER SHOULD ENCOURAGE AGGRESSIVE ATTEMPTS AT LOCAL CONTROL unless there is definite evidence that the disease has already disseminated beyond these zones (below the level of the clavicle). We have repeatedly obtained five or more years of control by neck dissection when the histological examination showed MULTIPLE INVOLVEMENT of the cervical lymph nodes, including those at the level of the thoracic duct (or right lymphatic duct), proving that although there was fairly extensive disease throughout the neck, nevertheless, metastatic tumor emboli had not permeated the main lymphatic ducts to produce generalized metastases. When cancer recurs following neck dissection, either in the operative field or elsewhere, the incidence of spread below the clavicle is fairly high,* reports to the contrary notwithstanding.[12, 28, 50]

OPERATIVE MORTALITY

The operative mortality for radical neck dissection per se in present-day surgical practice should not exceed 1 to 2 per cent, even when the operation is performed in unselected cases and despite any and all supposed medical contraindications (advanced age, cardiovascular disease, diabetes, alcoholism, liver disease, etc.). Postoperative pneumonia—now almost unknown—was formerly one of

* For many years the following statement made by the late George W. Crile, Sr. was quoted widely as an argument for neck dissection in mouth cancer: "We shall base our arguments largely upon the assumption that cancer is primarily a strictly local disease; that therefore accessible cases are at some period curable by complete excision; and that the immediate extension from the primary focus is through the regional lymphatic system. By a careful study of 4,500 cases from their original report in literature, made for me by Dr. Hitchings, in less than 1 per cent have secondary foci been found in distant tissues or organs."[18] Crile interpreted these figures to prove that in cancer of the upper respiratory and upper alimentary tracts the disease remained localized above the clavicle in 99 per cent of the cases even up to the time of death. One of us (H.M.) after an unsuccessful search of the literature for any published report of Hitchings's finally wrote to Crile asking for specific information concerning Hitchings, the source of his material, and such data that would aid in substantiating these figures.

In April, 1940, Crile answered as follows: "Regarding Dr. Hitchings, I can only say that he was a Harvard man, with excellent training. He was always most scholarly and thorough in his work, and painstaking in his desire for accuracy. Unfortunately, he died a few years ago, so I can not think of any way in which you could check his figures."[20] The inability to check the accuracy of Hitchings's observations, together with our clinical observations that systemic metastases occurred much more frequently, led us to investigate the autopsy records at Memorial Hospital. In 1941, Braund and Martin reported on the autopsy findings in 284 cases of patients dead of head and neck cancer and found an over-all incidence of 23 per cent of systemic metastases. In the final analysis, however, the faith in the curative value of neck dissection is valid without such arguments as those advanced by Crile.

TABLE 4

THE INCIDENCE OF DISTANT METASTASIS FROM VARIOUS SITES OF ORIGIN IN PATIENTS DEAD FROM CANCER OF THE UPPER RESPIRATORY AND ALIMENTARY TRACTS

Location of primary growth	No. of autops.	Cervical lymph-node metastases on admission	Distant metastases at autopsy	% with distant metastases
Lip	13	6	2	15.4
Mucosa of cheek	10	7	4	40.0
Floor of mouth	16	7	1	6.2
Gum	14	9	5	36.0
Tongue	60	30	11	18.3
Palate	11	5	3	27.0
Tonsil	27	18	3	11.0
Nasal cavity and sinuses	14	3	5	35.7
Wall of pharynx	8	6	2	25.0
Extrinsic larynx	38	25	7	18.4
Intrinsic larynx	17	1	2	11.8
Esophagus	56	2	21	37.5
TOTAL	284	119	66	23.2

the greatest postoperative hazards in neck dissection.

The published mortality rates for neck dissection vary from 3.7 to 12 per cent.[15, 27, 35, 38, 41, 48] When neck dissection is combined with excision of a primary lesion in the mouth, the operative risk will obviously be greater, but the mortality even in these should not exceed 4 to 5 per cent. The lower mortality rate (1 to 2 per cent) in neck dissection, and, as a matter of fact in all major surgery, was not possible before the advent of the antibiotics and chemotherapy and such surgical aids as intravenous (sodium pentothal) anesthesia and blood banks.

Formerly, when the operation of neck dissection was carried out under inhalation, rectal, or local anesthesia and when the importance of massive blood transfusions was not appreciated, the mortality of this operation was considerably greater (in some clinics more than 10 per cent) even though the patients were carefully selected from the medical standpoint. With an operative mortality approaching 10 per cent, it is obvious that "prophylactic" neck dissection in cancer of the lip would kill more people than could possibly be benefited by the operation.

The series of cases herein analyzed (665 operations) extends over a period of twenty years and, therefore, goes back into the era before these just-mentioned surgical aids were introduced. The operative mortality in this entire series of 665 operations is 3.4 per cent. There were no postoperative deaths in the last 100 cases of radical neck dissection alone (not combined with any other operation). The mortality in the last 100 combined operations (radical neck dissection plus excision of the primary lesion in the mouth with resection of the mandible en bloc) is 4 per cent. We emphasize again that these patients have not been selected as to risk. THE POLICY THAT THERE CAN BE NO MEDICAL CONTRAINDICATIONS TO AN OPERATION IN WHICH THERE IS A POSSIBILITY OF CURING CANCER HAS BEEN CONSISTENTLY FOLLOWED.

Though serious postoperative complications of neck dissection are usually multiple, they are often initiated by a single specific accident which usually occurs during the operative procedure. The complications have already been presented elsewhere under a separate heading. At this point it is more pertinent to discuss the general factors that have a bearing on operative mortality, and they may be itemized as follows:

1. Experience of the surgeon.
2. Age of the patient.
3. Incidence of cardiovascular disease.
4. Magnitude of the operation (combination of neck dissection with excision of the primary lesion within the mouth and section of the mandible).
5. Accidents occurring during the operative procedure for which the surgeon is clearly responsible.
6. Operative and postoperative complications beyond the control of the surgeon.

Experience of the Surgeon. In the clinical material herein analyzed, the operative mortality rate varied significantly among individual surgeons, being six times greater for the less experienced than for the more experienced surgeons. In the case of the Resident Surgeons, who during the latter part of their training frequently operate alone with the supervision of a member of the Attending Staff, the mortality rate was about average (3.4 per cent)—encouraging evidence that a trainee, having had adequate basic general surgical training, may obtain average proficiency in this operation under proper supervision.

In seeking for an explanation in the difference of operative mortality among individual surgeons, it appears probable that the more experienced surgeon operates faster with less blood loss and, therefore, less operative shock. Furthermore, by virtue of his experience, he

is more likely to avoid injury to vital structures and is immediately able to recognize and direct the treatment of such complications as pneumothorax or injury to the subclavian vessels.

Age of the Patient. In former years a commonly accepted reason for "inoperability" in consideration of a serious operation was "advanced age and poor general condition." In recent years this prejudicial surgical attitude is less pronounced and has largely disappeared in our clinic. Advanced age, in itself, is by no means a contraindication to operation.

In a recent statistical analysis made on the Head and Neck Service by Rasmussen and Moore,[54] it was found that the median age of the patients who died of complications following serious major operations in the head and neck is only three and a half years higher than the median age of the whole group—a difference of little statistical significance. In the series herein reported, the oldest patient was 92 years; there were two patients more than 90 and nine more than 80; in this group of nine patients there was one postoperative death.

The operation of neck dissection is often indicated in children. There were two cases younger than 10 years of age and thirteen less than 20. As might be expected, the mortality in the young age group is inappreciable.

Combinations of Surgical Procedures. When neck dissection is combined with the excision of a primary lesion in the mouth (necessitating section of the mandible) or with thyroidectomy, laryngectomy, parotidectomy, etc., the procedure is obviously of longer duration, more anatomical structures are encountered, and therefore the chances of surgical accidents during the course of the operation are greater. It may be expected, therefore, that the mortality rate following the combined operations will be higher. In the last 100 cases of combined procedures (neck dissection plus excision of a primary lesion in the mouth and section of the mandible), the operative mortality has been 4 per cent as compared to none when only neck dissection is performed and is not combined with an additional extensive procedure.

(The operation of combined neck dissection and total laryngectomy is not included in the series of 665 operations on which the statistical analysis in the present study is based; this procedure has been employed on the Head and Neck Service only since 1947 and to date has been performed in eighty-two cases. There have been three postoperative deaths in this whole series, and at the present time the mortality is 3.7 per cent. There were no postoperative deaths in the last fifty-four operations of combined neck dissection and total laryngectomy.)

Accidents During the Operation for Which the Surgeon Is Clearly Responsible. While on the basis of average mortality rates the operation of radical neck dissection per se can hardly be classified as a hazardous procedure in the hands of a trained surgeon, nevertheless, certain accidents—sometimes resulting fatally—can take place during the operation for which the surgeon himself is clearly responsible. Such accidents can occur to anyone, but they should be proportionately less in the hands of a skilled and experienced surgeon who employs a careful technique, particularly in the handling of certain vital structures, such as the common and internal carotid arteries, the subclavian vessels, the vagus and other nerves, and the pleura.

The most frequent preventable accident occurs in dissecting about the larger blood vessels. Injudicious handling of a previously scarred arterial wall, or of an artery invaded by growth, or the rough, jerky clamping of a large atheromatous artery may produce a tear that cannot be repaired without sacrificing the vessel itself. Deliberate clean surgery is the best safeguard against operative accidents.

There still remain those cases, however, in which the surgeon is faced with the grave decision of elective sacrifice of the common or internal carotid artery so as to remove a focus of cancer. In deciding not to resect the invaded vessel, he may be depriving the patient of a chance of cure. In electing to sacrifice either the common or internal carotid arteries, he must anticipate an almost 50 per cent chance of losing the patient. No matter what decision is made, the philosophically minded surgeon can hardly be certain that he is always correct. If he elects to leave the artery intact together with an area of attached tumor, he must consider that possibly the patient might have survived the arterial resection and gone on to a cure. If the resection is attempted and the patient dies as a result of

the procedure, the surgeon will realize that by leaving the artery in place the patient might have had months of reasonably comfortable life and that possibly the residual disease might have been controlled permanently by supplemental radiation therapy. Cases in which section of the artery is followed by hemiplegia and death within the first few postoperative days are too common to require any particular comment. Examples of the clinical course in cases in which the artery with invading cancer was left intact are given in the following two case reports.

CASE 1. J. S., age 82 years, was undergoing neck dissection for palpable cervical metastasis six months after eradication of a tongue cancer by radiation therapy. A metastatic node was found to invade the common carotid artery directly at its bifurcation. Complete excision of the disease would have necessitated ligation of the vessel. A decision was made not to resect the artery for the following reasons: The patient was 82 years old, in robust general health, and the head of a large and devoted family. In part, the decision was based on the philosophical grounds that it was more reasonable to permit the patient, who was not suffering from any appreciable discomfort, to live out his probable allotted span rather than to take the almost fifty-fifty chance of an immediate mortality. Accordingly, a plaque of disease was left attached to the artery and gold radon seeds were implanted in the arterial wall. The skin flaps were then closed and the skin marked for a later tattoo to establish the exact position of the residual focus of cancer. As soon as the wound was healed, fractionated roentgen-ray radiation was given over the tattooed area. The local growth never became active and the disease did not recur elsewhere during the patient's lifetime. He lived for an additional one and a half years without any discomfort or disability and then died of other causes incident to his advanced years and unrelated to his cancer.

CASE 2. H. M., age 34 years, was admitted with advanced cancer of the extrinsic larynx and cervical metastasis. A surgical program consisting of a radical neck dissection combined with total laryngectomy was planned. During the neck dissection (which precedes laryngectomy), a matted mass of metastatic nodes was found to invade the common carotid artery just below its bifurcation. The question then arose as to further procedure. A decision was made not to resect the artery on the following basis: Owing to the bulk and extent of the disease, the chances of permanent cure were considered to be practically nil. The patient was 34 years old, in good general health, and the head of a family of four small children. At best it was felt that if the artery were not resected, the patient might survive several additional months. The vessel and its attached disease was, therefore, left intact and the larynx containing a bulky tumor removed for palliative reasons (otherwise a tracheostomy was mandatory). The patient remained comfortable for several months and then succumbed to local extension of the growth.

There remain the accidents which are due to tearing of an atheromatous arterial wall. Such trauma is most likely to occur in the hasty clamping of blood vessels like the transverse cervical or the superior thyroid artery TOO CLOSE TO THE MAIN ARTERY ITSELF. If the vessel breaks at the site of the applied hemostat, it is sometimes impossible to secure the bleeding point with a ligature; and in striving to do so, the main artery itself, atheromatous and brittle, is opened. Naturally, an attempt to suture the tear suggests itself and such a maneuver sometimes succeeds in arresting the hemorrhage. More often, the only means of controlling the bleeding is to ligate the main artery, and in such cases there should be little hesitation, since there is no alternative to immediate death from hemorrhage.

Operative Deaths from Causes Beyond the Control of the Surgeon. In any large surgical series of cases, operative deaths will occur that are beyond the control of the surgeon—deaths that are a matter of pure coincidence rather than of causal relationship. In the present series there were three instances of cerebral-vascular accident and three of coronary thrombosis.

END RESULTS

In conformance with the usual standards of end-result reporting in cancer, we have taken a five-year period of freedom from disease (from the first admission of the patient to Memorial Hospital) as evidence of a cure. Although it is well known that cancer may recur even after a five-year period of freedom from disease, nevertheless, the five-year result is generally accepted as the most practical and reasonable standard.

Cervical metastasis or recurrence after neck dissection, if any at all, usually becomes evi-

TABLE 5

FIVE-YEAR END RESULTS IN NECK DISSECTION

(Neck dissection alone, combined procedures not included)

Head and Neck Service, Memorial Hospital 1928 to 1945, Inclusive

Total Patients		334
Indeterminate Results		
Dead from other causes without recurrence	28	
Lost track of without disease	3	
Total indeterminate results		31
Determinate Results		
Total number minus indeterminate results		303
Failures		
Postoperative death	10	
Lost track of with disease	2	
Dead as a result of cancer	177	
Dead of other causes, cancer present	3	
Living with cancer	4	
Dead—presence of cancer unknown	3	
Total number of failures		199
Successful Results		
Free of disease at five years from neck dissection		104
Five-year End Results		
Successful results divided by total determinate results (104/303)		34.3%

dent within the first few months or a year following the treatment of the primary lesion. There are, however, exceptions to this rule. The longest case on record at Memorial Hospital of a delayed appearance of cervical metastasis following control of the primary lesion is that of a female patient with cancer of the tongue first treated by radiation therapy in 1943 with complete disappearance of the primary lesion. She remained free of disease until 1949 (more than six years) when a cervical node became palpable on the homolateral side; neck dissection was accomplished without difficulty. The surgical specimen showed metastatic cancer. Such an event in no way affects the practical validity of a five-year basis in calculating end results.

In the 599 cases analyzed for the present report, 303 cases may be considered as determinate, that is, cases in which neck dissection could either be given the credit for cure of metastatic cancer or in which death from cancer was due to the failure of neck dissection to control the disease. Among the cases excluded from this group were those in which metastasis was not found in the surgical specimen, and in which, therefore, it could not be claimed that the neck dissection played a decisive role, those on whom combined operations were performed or in whom the primary was not thought to be controlled. The largest additional group classified as indeterminate are those patients who died of other causes unrelated either to the cancer or to its treatment.

The five-year–cure rate of neck dissection in this series of cases was 34 per cent as shown in Table 5.

PROGNOSIS

A great deal can be learned about specific diseases and the methods of treatment by a calculation of cure rates in minority groups that are designated on the basis of individual factors relating to the patient or to the methods of treatment. It is the policy in our clinic to designate such studies under the title of "Factors Influencing the Prognosis for Cure" (Table 6). These factors are discussed individually under the headings that follow.

Age at Time of Operation. The prognosis for cure following neck dissection appears to be rather constant through the fourth, fifth, sixth, and seventh decades of life, dropping from about 33 per cent to 21 per cent in the eighth decade of life. It seems reasonable to conclude from these figures that neck dissection should not be denied to any patient for reasons of age alone. The less favorable prognosis in the eighth decade of life is not adequately explained by an analysis of the available data. It is significant that the operative mortality is not appreciably higher in the older age groups.

Sex. According to Table 6, the prognosis for cure by neck dissection is the same for males as for females. When the apparent difference, 4.7 per cent, is measured by its sigma (σ), the result 0.6 is not significant and could happen by chance alone.

Site of the Primary Lesion. The prognosis following neck dissection is much better in cancer of the lip and intrinsic larynx than in other anatomical forms of head and neck cancer. It must be emphasized again that the cases in which these figures were obtained were those in which all surgical specimens contained positive nodes; otherwise, it might be construed that prophylactic neck dissections in less malignant varieties, such as can-

TABLE 6

FACTORS INFLUENCING THE PROGNOSIS IN 303 DETERMINATE PATIENTS WITH NECK DISSECTION*

Factors	Total Patients	5-yr. cure rate No.	5-yr. cure rate %
1. *Age at Operation*			
39 and under	34	13	38.2
40–49	43	16	37.2
50–59	94	35	37.2
60–69	99	33	33.3
70–79	28	6	21.4
80 and over	4	1	25.0
Unknown	1	—	0.0
TOTAL	303	104	34.3
2. *Sex*			
Male	257	90	35.0
Female	46	14	30.4
TOTAL	303	104	34.3
3. *Site of the Primary Lesion*			
Lip	46	22	47.8
Buccal mucosa	27	8	29.6
Gum	15	4	26.6
Palate	10	3	30.0
Floor of mouth	23	5	21.7
Tongue	111	35	31.5
Intrinsic larynx	15	9	60.0
Nasal cavity, nasopharynx, pharyngeal wall, extrinsic larynx, paranasal sinuses	14	—	0.0
Thyroid, eye, parotid, tonsil, skin of head and neck	42	18	42.9
TOTAL	303	104	34.3
4. *Pathology of the Primary Lesion*			
Adenocarcinoma	17	9	52.9
Epidermoid carcinoma	230	78	33.9
Melanoma	9	1	11.1
†Other	47	16	34.0
TOTAL	303	104	34.3
5. *Chronology of Cervical Metastasis*			
Present on admission	122	40	32.8
Developed subsequently	177	63	35.6
Unknown	4	1	25.0
TOTAL	303	104	34.3
6. *Number of Nodes Involved*			
One	116	50	43.1
More than one	187	54	28.9
TOTAL	303	104	34.3
7. *Postoperative Recurrences*			
None	90‡	77	85.6
In operative field	112	12	10.7
Other patients positive for recurrence but not in operative field	101	15	14.9
TOTAL	303	104	34.3

* Clinical material limited to those cases in which the excised nodes were positive for cancer, the primary site was known to be in the head and neck, and the operative procedure was a neck dissection alone and not combined with other operations, such as resection of the mandible, thyroidectomy, or excision of the parotid salivary gland. All end results are determinate. This footnote applies also to Table 5.

† There are other morphological types of metastatic cancer in which neck dissection was performed in this series, but the numbers are too small to be of any statistical significance.

‡ There were 10 postoperative deaths.

Three patients died of late effects of treatment with no evidence of cancer.

cer of the lip, were included (negative nodes). Figi reported 39 per cent of five-year cures in cancer of the lip with positive nodes. Morrow obtained 12 per cent of five-year cures in cancer of the tongue with positive nodes.

It may be significant, although it probably should not be regarded as conclusive, that there were no five-year cures in a total of fourteen cases of neck dissection for cancer of the extrinsic larynx, nasopharynx, pharyngeal wall, nasal cavity, and paranasal sinuses. Since the termination of this study (1945) a number of five-year cures have been noted in the latter cases by neck dissection.

Pathology. As might be expected, the best cure rates for neck dissection are obtained in cases of adenocarcinoma, usually of salivary- or thyroid-gland origin (about 53 per cent). The next most favorable prognosis is to be found in the over-all group of epidermoid carcinoma (about 34 per cent). In the present series there was one cure by neck dissection in nine cases of metastatic melanoma.

Chronology of Cervical Metastasis. If cervical metastasis was present on admission, the five-year–cure rate by neck dissection proved to be a little over 33 per cent; whereas, if metastasis developed subsequently, the cure rate was slightly higher—about 36 per cent. This difference might be attributed to the fact that, when metastasis was present on admission, there was a dual problem, that is, the treatment of the primary site as well as the disease in the neck. When cervical metastasis developed after admission (i.e., after eradication of the primary lesion), only a single problem was involved, that is, the management of the metastatic nodes in the neck; thus, the neck dissection could be carried out at an elective time under more favorable circumstances than if the primary lesion were also present. Actually, the extent of the lymph-node involvement in the two categories is essentially the same, that is, when neck dissection is deferred until there is clinical evidence of cervical metastasis or when prophylactic neck dissection is performed. This fact gives little support to those who favor prophylactic (elective) neck dissection.

Number of Nodes Found to be Involved in the Surgical Specimen. The prognosis appears considerably more favorable when only one lymph node is found to be involved by cancer on histological examination of the surgical specimen (43 per cent) than if multiple nodes are involved (29 per cent). These figures indicate that multiple node involvement by no means infers a hopeless prognosis.

Postoperative Recurrences in the Neck Following Neck Dissection. In those cases in which there were no recurrences following

neck dissection the cure rate in ninety cases was 86 per cent. It is significant, however, that there was some salvage even after local recurrence in twelve cases (11 per cent). The credit for cure for these recurrences was divided about equally between surgery and radiation therapy.

Bilateral Neck Dissection. If a patient presents himself with bilateral cervical metastases, or if contralateral cervical metastasis develops subsequent to neck dissection, the prognosis is not necessarily hopeless. In this series, bilateral neck dissection was performed in fifty cases, and a five-year–cure rate of about 30 per cent was obtained. The most frequent indications for bilateral neck dissection are cervical metastasis secondary to thyroid and lingual cancer respectively.

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